



Effect of calcium hypochlorite on the flotation separation of galena and jamesonite in high-alkali systems



Runqing Liu, Yanzhe Guo, Li Wang, Wei Sun*, Hongbiao Tao, Yuehua Hu*

Central South University, People's Republic of China

ARTICLE INFO

Article history:

Received 3 December 2014

Revised 5 September 2015

Accepted 10 September 2015

Available online 25 September 2015

Keywords:

Flotation separation

Galena

Jamesonite

High-alkali pulp

Calcium hypochlorite

ABSTRACT

Jamesonite and galena have similar flotation properties, leading to difficulties in effectively separating these two minerals by means of conventional flotation. This study assessed the depressing effect of calcium hypochlorite $[\text{Ca}(\text{ClO})_2]$ on the flotation separation of galena and jamesonite in high-alkali systems. Flotation test results show that galena and jamesonite have substantially different floatability in high-alkali systems. The addition of $\text{Ca}(\text{ClO})_2$ depresses the flotation of jamesonite, but the depressant is unselective against galena. A flotation separation test of a mixture of galena and jamesonite was conducted. The results show that the recovery of galena and jamesonite is 92.26% and 89.75%, respectively. Adsorption measurements and infrared spectral analysis indicate that when diethyldithiocarbamate (DDTC, collector) interacts with galena and jamesonite, chemical adsorption occurs on the mineral surfaces, producing hydrophobic lead diethyldithiocarbamate (PbD_2). In a high-alkali solution, $\text{Ca}(\text{ClO})_2$ exhibits little interference regarding the adsorption of DDTC on the galena surface, while it significantly inhibits the adsorption of DDTC on jamesonite. The flotation behavior of jamesonite is depressed by $\text{Ca}(\text{ClO})_2$ mainly because the latter enhances the surface hydrophilicity of the former. These results provide a reference for separating galena and jamesonite concentrates prior to smelting.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Lead (Pb) is an important metal in modern industrial development and is widely used in the chemical and military industries, as well as in electronics (e.g., the production of batteries and alloys). The major sources of Pb are natural minerals, such as galena, cerussite, and jamesonite (Chen and Peng, 2008; Hu, 2014; Wang, 2012). Antimony (Sb) is a type of metal that is as important as Pb in industry, and it is commonly used in alloys, printing, and chemicals as well as the military industry. The major mineral sources of Sb include stibnite, jamesonite, and pyrargyrite (Hu and Feng, 2006). Jamesonite ($\text{Pb}_4\text{FeSb}_6\text{S}_{14}$) contains 40.15% Pb, 2.71% Fe, 35.39% Sb, and 21.75% S. Jamesonite belongs to low to moderate temperature hydrothermal deposits, which mainly come from copper–lead–zinc multimetallic deposits and cassiterite–sulfides deposits (Anthony et al., 2005). Jamesonite was first identified in 1825 in Cornwall, England (<http://www.mindat.org/min-2072.html>). Later, it was found in South Dakota and Arkansas, USA; Zacatecas, Mexico; Romania; and China. Jamesonite frequently

co-exists with other sulfide minerals, such as pyrite, pyrrhotite, galena, marmatite, tetrahedrite and boulangerite. Corrosion and metasomatism commonly occur between jamesonite and galena because of their complex boundary and close symbiosis (Sun and Li, 2007). Both jamesonite and galena have good floatability. Jamesonite has a higher Pb content, so the flotation property of the material is more akin to galena than to stibnite (Lager and Forssberg, 1989a,b). Therefore, it is difficult to effectively separate galena and jamesonite by means of conventional flotation.

Xanthate, butylamine aerofloat, and diethyldithiocarbamate (DDTC) are common collectors for galena flotation. Furthermore, mixtures of collectors are commonly used in flotation, and a range of performance benefits can be obtained (Lotter and Bradshaw, 2010; McFadzean et al., 2013). This is a synergistic effect (Bradshaw, 1997; Wilson et al., 2000). For example, McFadzean et al. (2012) showed that mixtures of ethyl xanthate with diethyl dithiophosphate or ethyldithiocarbamate resulted in large improvements in the flotation rate and recovery with pure galena in a microflotation cell. DDTC has a good collecting ability on galena over a wide pH range; it is considered to be more suitable than xanthate for galena flotation in high-alkali systems (Zhang, 2007, 1996; Wang, 2008; Li et al., 2009). Gu and Qin (Gu et al.,

* Corresponding authors.

E-mail addresses: sunmenghu@126.com (W. Sun), hyhcsu@163.com (Y. Hu).

2002a; Qin et al., 1996) also showed that high-alkali mediums are conducive to the flotation of galena. Additionally, DDTC and xanthate have a good collecting ability for jamesonite flotation. Chemical adsorption occurs on the jamesonite surface in the presence of DDTC, whereas ethyl xanthate interacts with jamesonite to produce Pb xanthate and dixanthogen (He, 2012; Wang, 1992; Yu et al., 2004; Zhang et al., 2006). Jamesonite has good floatability in acidic or neutral mediums, with decreased floatability at pH > 8 and little floatability at pH = 11 (Li et al., 2006; Zhang et al., 2004; Yu et al., 2004).

In the flotation separation of sulfide minerals, dichromate, sulfite, cyanide, or lime is commonly used as a depressant. Dichromate or sulfite depresses galena flotation when the galena surface is oxidized; the former can also depress jamesonite flotation at a natural pH (Wei and Sun, 2008; Zhang et al., 2005). Cyanide strongly inhibits the flotation of minerals, such as pyrite, sphalerite, and chalcopyrite, but it barely affects galena or jamesonite flotation (Lu, 2011; Chen et al., 2005; Zhang et al., 2004; Liu et al., 1994). Interestingly, jamesonite is more sensitive to lime than galena (Deng and Xu, 1990). Hallimond flotation marginally reduces the recovery of galena in the presence of calcium and sulfate ions using potassium amyl xanthate as the collector (Ikumapayi et al., 2012; Ikumapayi and Rao, 2014). Calcium ions caused significant galena depression using a dithiophosphate collector. In contrast, galena recovery was unaffected by thiosulphate in the absence of calcium ions (Grano et al., 1997). Liu et al. (2007) indicated that a low concentration of calcium ions cannot depress the flotation of galena unless the ionic concentration reaches 1000 mg/L. In a galena-lime-DDTC system, a given amount of lime can not only adjust the solution pH but can also stabilize the pulp potential, favoring galena flotation (Wang et al., 1998; Gu et al., 2002). Finkelstein and Allison (1976) stated that galena floats selectively from sphalerite in a slightly alkaline environment (pH 8–10). Higgins and Quast (1992) showed that the addition of lime tended to depress galena flotation slightly and substantially depress marmatite flotation. Quasta and Hobart (2005) separated marmatite from galena and found that alkaline conditions resulted in good selectivity while maintaining a high lead recovery. However, the flotation of jamesonite is strongly depressed in high-alkali systems adjusted with lime, mainly due to the competitive adsorption between $\text{OH}^-/\text{Ca}(\text{OH})^+$ and DDTC on the jamesonite surface (Yu, 2004).

There have been numerous reports on the depressants of sulfide minerals. For example, DHDP, FCLS, multi-hydroxy dithiophosphate, and dextrin are used to depress galena (Zhang, 1998; Piao et al., 2013; Liu et al., 2009; Rath and Subramanian, 1999; Drzymala et al., 2003; Lopez-Valdivieso et al., 2007). RC, DMPS, mercaptoacetic acid, and mercaptoethanol have been studied to separate pyrrhotite, marmatite, and jamesonite or other sulfide minerals (Zhang et al., 2006; Sun et al., 2005; Liu et al., 2006). A large number of studies have reported on the flotation separation of polymetallic sulfide minerals. However, the separation flotation of galena and jamesonite has not been extensively studied. In the conventional flotation process, mixed concentrates of galena and jamesonite are smelted directly, resulting in high energy consumption, environmental pollution, and substantial costs (He, 2012; Wang, 2001). To avoid the above issues, it is necessary to separate galena and jamesonite prior to smelting.

In this study, the flotation separation of galena and jamesonite was studied as a function of the pH value and the dosage of the depressant and collector. The mechanisms underlying the mineral–reagent interaction were further investigated by adsorption measurements and infrared spectral analysis. The results provide a reference for effectively separating galena and jamesonite before smelting.

2. Materials and methods

2.1. Materials and reagents

Galena and jamesonite samples were obtained from the Fankou Mine in Guangdong Province and the Dachang Mine in Guangxi Province, China, respectively. The samples were handpicked, crushed and ground in a laboratory porcelain mill. The powder samples were then screened. The $-0.075 + 0.038\text{-mm}$ sized fraction was used for single-mineral flotation tests, and the -0.038-mm sized fraction was used for infrared spectral analysis. All of the samples were stored in sealed glass bottles. X-ray diffraction analysis was performed to characterize the chemical and mineral compositions (Figs. 1 and 2), and chemical analysis was performed to determine the purity of the minerals. The XRD results showed that the samples were very pure, and chemical analysis showed that the galena and jamesonite samples were 97.2% and 95.7% pure, respectively.

Flotation tests were conducted using $\text{Ca}(\text{OH})_2$ and HCl as the pH regulators, DDTC as the collector, calcium hypochlorite [$\text{Ca}(\text{ClO})_2$] as the depressant, and terpenic oil as the frother. All reagents for the tests were of analytical grade, except for the terpenic oil, which was of industrial grade.

2.2. Flotation tests

Single-mineral flotation tests were conducted in a 40-mL hitch groove flotation cell. The impeller speed was fixed at 1800 r/min. For each test, 2 g of sample was taken, and the mineral surface was cleaned for 5 min using an ultrasonic cleaner to remove any oxide. The sample was allowed to settle, and the upper liquid layer was decanted. The sample was flushed with 40 mL of distilled water, and the solution pH value was adjusted using HCl or $\text{Ca}(\text{OH})_2$. Then, the suspension was conditioned with depressant for 2 min, collector for 2 min, and frother for 1 min, followed by flotation for 4 min. The products were filtered, dried, and weighed. The recovery of mineral ε is calculated by

$$\varepsilon = \frac{m_1}{m_1 + m_2} \times 100\% \quad (1)$$

where m_1 and m_2 are the weights of the float and non-float fractions, respectively. The experimental data had an average of 5 measurements, and the error bars are based on the standard deviation.

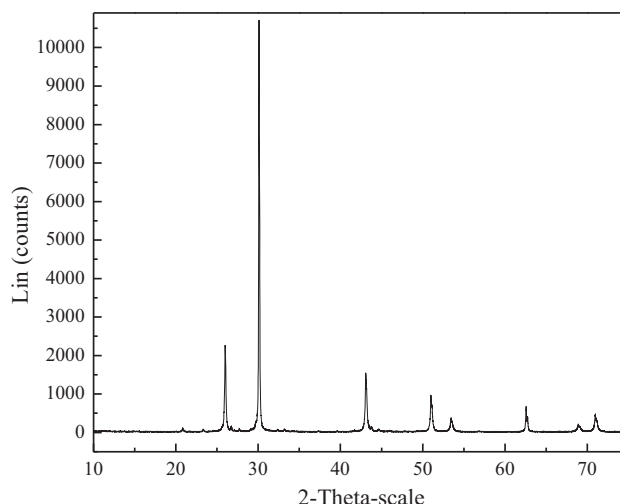


Fig. 1. X-ray diffraction of galena sample.

Download English Version:

<https://daneshyari.com/en/article/232915>

Download Persian Version:

<https://daneshyari.com/article/232915>

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