

Studies on interaction mechanism of fine wolframite with octyl hydroxamic acid



Qingyou Meng, Qiming Feng, Qing Shi*, Leming Ou

School of Mineral Processing and Bioengineering, Central South University, Changsha 410083, China

ARTICLE INFO

Article history:

Received 7 January 2015

Revised 31 March 2015

Accepted 3 May 2015

Available online 11 June 2015

Keywords:

Wolframite

Flotation

Hydroxamic acid

Adsorption

ABSTRACT

Interaction mechanism of fine wolframite with octyl hydroxamic acid (OHA) during flotation process was investigated. Flotation and adsorption tests indicated that wolframite showed better floatability as a consequence of OHA adsorption at pH 7.0–10.0. Zeta-potential measurements revealed that OHA adsorbed specifically on wolframite surface. The results of solubility behavior of wolframite indicated that the anion-exchange reaction occurred between OHA^- in solution and WO_4^{2-} in the crystal lattice. OHA^- might interact with $\text{Mn}^{2+}/\text{Fe}^{2+}$ cations of wolframite surface to form ferrous/manganous hydroxamate precipitations, with a release of WO_4^{2-} ions. The XPS analysis confirmed that the mechanism of OHA adsorption onto wolframite surface associating coadsorption/surface reaction process was presented in flotation conditions. OHA could bond with ferrous/manganous species on wolframite surface, accompanying molecule OHA physical adsorption onto the chemisorbed layer of ferrous/manganous hydroxamate precipitations. This interaction process appeared to be strong enough to ensure adequate adsorption ability of OHA on wolframite surface and led to good hydrophobicity of wolframite.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Tungsten, as a rare and refractory metal, is widely used in modern science and technology (Koutsospyros et al., 2006). Tungsten is usually extracted from tungsten-containing ores, among which the most widespread is wolframite ((Fe, Mn)WO₄). Wolframite concentrate is mainly recovered through gravity and magnetic separation, but fine particles fraction has suffered substantial losses, especially for the particles below 20 μm (Srivastava and Pathak, 2000; Bhagat and Pathak, 1996). Therefore flotation becomes an important method for fine-grained and complex wolframite ore (Pradip, 1996). Flotation is a physical–chemical separation process based on differences of surface properties between valuable and gangue minerals (Nguyen, 2007). The difference is usually obtained and/or expanded using specific reagents, such as collectors, activators, and depressants.

Selecting effective collectors to enhance the floatability of fine wolframite is very important in terms of its poor natural hydrophobicity. Currently, hydroxamic acids and their salts have been extensively studied and used in flotation due to their strong and selective chelation with some metal ions (Natarajan and Fuerstenau, 1983; Buckley and Parker, 2013; Fuerstenau et al.,

2000). Previous reviews indicated that adsorption of hydroxamic acids on mineral surface involved either transition metal or rare-earth metal ions in the crystal lattices (Pavez et al., 1996; Fuerstenau and Pradip, 1984; Pradip, 1987), such as cassiterite and rare-earth minerals. Hydroxamate collectors could effectively increase wolframite's floatability as a result of the formation of ferrous/manganous hydroxamate precipitations (Hu et al., 1997; Bogdanov et al., 1973; Yang et al., 2014). Nevertheless, the surface properties of fine wolframite and the details about the interaction mechanism between hydroxamic acids and minerals have not been studied systematically in wolframite flotation. To choose and design effective surfactants for good flotation performance, fundamental studies of mineral–surfactant interaction are very important. The aim of this paper is to investigate systematically on flotation behaviors and interaction mechanism of fine wolframite with octyl hydroxamic acids (OHA) through flotation experiments, adsorption tests, zeta-potential measurements, ICP-AES, and XPS analysis.

2. Materials and methods

2.1. Materials

Wolframite used for all experiments was obtained from Yao Gangxian, Hunan Province, China. Chemical analysis and X-ray

* Corresponding author.

E-mail addresses: feng_309@csu.edu.cn, qing_shi@csu.edu.cn (Q. Shi).

powder diffraction data confirmed that wolframite samples were of high purity (98%). The samples were ground and then elutriated to collect the $-10\ \mu\text{m}$ fraction for flotation tests. Analytical grade hydrochloric acid (HCl) and sodium hydroxide (NaOH) were used as pH regulators. Octyl hydroxamic acid (OHA), using as collector, was prepared in laboratory. Distilled water was used for all tests.

2.2. Experiments

2.2.1. Flotation tests

Single mineral flotation tests were conducted in a mechanical agitation flotation machine. Mineral suspension was prepared by adding 2.0 g sample to 40 mL distilled water. The mineral suspension was firstly adjusted to a desired pH value by adding NaOH or HCl and conditioned for 2 min. Then OHA was added into the suspension and conditioned for 3 min. Flotation froth was scraped out every 10 s for a total of 5 min. The flotation recovery was calculated based on solid weight distributions between float and sink particles.

2.2.2. Adsorption tests

The amount of adsorbed OHA was determined based on the difference between the initial and final OHA concentrations in mineral suspension. OHA concentration was measured using UV absorbance at 507 nm based on the ferric hydroxamate method. 1.0 g sample was conditioned with 40 mL OHA solution at a desired pH value. The obtained suspension was shaken for 12 h at 25 °C. The slurry was centrifuged at 9000 rpm for 10 min, and OHA concentration of the supernatant was measured by spectrophotometer (UV-2600, Shimadzu, Japan).

2.2.3. Zeta-potential measurements

Zeta-potential measurements of wolframite were carried out using a Zeta Plus meter (Brookhaven, USA). Potassium chloride was used as background electrolyte to maintain the ionic strength at $10^{-2}\ \text{mol L}^{-1}$. 30 mg sample with particle size below $5\ \mu\text{m}$ was mixed with 40 mL electrolyte solution with/without adding OHA. The pH value was adjusted using NaOH or HCl and measured using a pH meter (F-50C). The suspensions were magnetically stirred for 5 min, and the zeta-potential of sample was then measured using a zeta-potential meter. Average values of three measurements and standard deviations were calculated for each point.

2.2.4. ICP-AES measurements

Analysis of ion concentrations dissolved from wolframite surface was carried out via inductively coupled plasma-atomic emission spectroscopy (ICP-AES). 2.0 g wolframite sample was conditioned in 40 mL distilled water solutions with/without adding OHA at a desired pH value. The suspension was stirred for 30 min at 25 °C. The samples were centrifuged at 9000 rpm for 10 min, and ion concentrations of the supernatant were measured by ICP-AES (PS-6, Bird, USA).

2.2.5. X-ray photoelectron spectroscopy

X-ray photoelectron spectroscopy (XPS) measurements were conducted using a Thermo Fisher ESCALAB 250Xi XPS system. Binding energy values were referred to the C1s peak (284.8 eV) from the adventitious contamination during data processing of the XPS spectra. The samples were conditioned using the same procedure as the flotation tests with/without adding OHA. The prepared samples were filtrated and rinsed two times with 40 mL distilled water in order to remove weakly adsorbed collector, and then dried in a vacuum oven before XPS measurements.

3. Results and discussion

3.1. Flotation and adsorption

Fig. 1 shows the effect of pH on wolframite flotation performance with $120\ \text{mg L}^{-1}$ OHA. According to Fig. 1, the recovery of wolframite firstly increased and then decreased with the increase of pH. A maximum recovery occurred at around pH 9.0 and better wolframite floatability could be achieved over the pH range from 7.0 to 10.0. The effect of collector concentration on the wolframite flotation performance is shown in Fig. 2. An obvious increase in flotation recovery was observed with the increase of collector concentration, and the maximum recovery reached 92% with the collector concentration of $60\ \text{mg L}^{-1}$, above which the recovery remained constant.

Figs. 1 and 2 also show that the amount of OHA adsorbed on wolframite surface depended on pH values and OHA concentrations. Consistent variation trends observed from Figs. 1 and 2 between collector adsorption and mineral recovery suggested that the adsorption of OHA contributed to the increase of wolframite floatability.

3.2. Zeta-potential tests

The zeta-potentials of wolframite with/without $120\ \text{mg L}^{-1}$ OHA at different pH values are presented in Fig. 3. The surface of

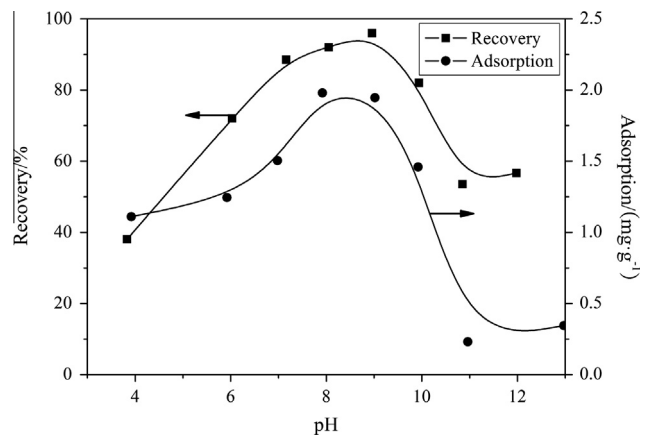


Fig. 1. Effect of pH on the recovery of wolframite and adsorption of OHA on wolframite ($c_{\text{OHA}} = 120\ \text{mg L}^{-1}$).

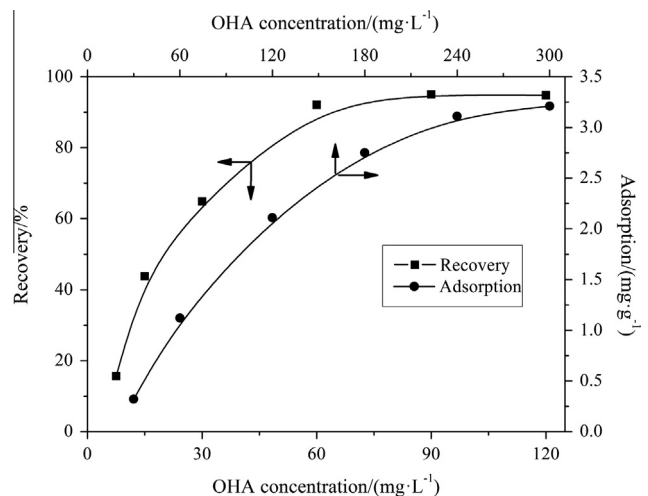


Fig. 2. Effect of OHA concentration on the recovery of wolframite and adsorption of OHA on wolframite (pH = 8.5–9.0).

Download English Version:

<https://daneshyari.com/en/article/232943>

Download Persian Version:

<https://daneshyari.com/article/232943>

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