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Original Article

# The critical importance of pulp concentration on the flotation of galena from a low grade lead–zinc ore

Xianping Luo[a,b], Bo Feng[a,b,*], Cunjian Wong[a], Jiancheng Miao[c], Bin Ma[c], Hepeng Zhou[a]

[a] Jiangxi Key Laboratory of Mining Engineering, Jiangxi University of Science and Technology, Ganzhou, China
[b] Western Mining Co., LTD, Qinghai Key Laboratory of Plateau Comprehensive Utilization and Mineral Processing Engineering, Xining, China
[c] Nanjing Yinmao Lead-Zinc Mining Co., Ltd., China

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ABSTRACT

The Qixia orebody is a complex lead–zinc sulfide system with pyrite gangue and minor amounts of copper. In order to improve the flotation results, laboratory scale flotation testing of ore samples taken from this operation was performed. Flotation tests used a sequential recovery protocol for selective flotation of first the lead and thereafter the zinc. The key parameters that influence flotation performance of lead mineral were tested in this paper. The test data show that, for comparable collector, grinding time, flotation pH and solid-in-pulp concentration, the increase of solid-in-pulp concentration has the most significant effect on the recovery and selective separation of lead mineral. The increase of solid-in-pulp concentration from 27% to 55% makes the recovery of lead mineral increased from 60% to 80% and the lead grade increased from 27.5% to 29.1%.

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## 1. Introduction

Lead and zinc metals are widely used in the fields such as electrical, mechanical, military, metallurgical, chemical, light and medical [1]. As an important resource of lead and zinc mineral, sulfide ore plays an important role in the development of world economy. However, in most cases, lead–zinc–iron sulfide ores are grouped together in the deposits [2].

In general, there are two basic approaches to achieve lead–zinc sulfide mineral separation: to depress zinc sulfide and float lead sulfide, or a bulk lead sulfide and zinc sulfide concentrate is floated first, followed by the Pb–Zn separation [3,4]. In the past decades, many studies on flotation separation of lead–zinc sulfide ores have been carried out [5–7].

The Qixia orebody located in Jiangsu province of China is a complex lead–zinc sulfide system with pyrite gangue and minor amounts of copper. In order to improve the flotation

* *Corresponding author.*
E-mail: fengbo319@163.com (B. Feng).
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**Table 1 – The main chemical composition of the lead–zinc ore sample (mass fraction,%).**

| Element | Cu | Pb | Zn | Fe | S | Mn | CaO |
|---|---|---|---|---|---|---|---|
| Content | 0.12 | 1.30 | 3.15 | 28.88 | 30.06 | 2.27 | 6.68 |

| Element | MgO | $Al_2O_3$ | $SiO_2$ | Others |
|---|---|---|---|---|
| Content | 1.05 | 0.56 | 8.45 | 17.48 |

**Table 2 – The mineral composition of the lead–zinc ore sample (%).**

| Mineral | Content | Mineral | Content | Mineral | Content |
|---|---|---|---|---|---|
| Pyrite | 43.45 | Graphite | 0.50 | Marcasite | Trace |
| Sphalerite | 9.50 | Quartz | 14.06 | Magnetite | Trace |
| Galena | 4.28 | Clay minerals | 1.52 | Pyrrhotite | Trace |
| Chalcopyrite | 0.26 | Calcite | 25.10 | Covellite | Trace |
| Tetrahedrite | 0.30 | Sericite | 1.00 | Hematite | Trace |

performance of this ore, many studies have been done. However, the flotation performance is difficult to be improved although many reagents and flotation flowsheets have been tested. In this study, some factors that may influence the flotation performance of this ore were tested. The objective of this study is to point out a solution to the flotation problem of low grade lead–zinc sulfide ore.

## 2. Experimental

### 2.1. *Materials and reagents*

The lead–zinc ore was supplied by Nanjing Yinmao Lead-zinc Mining Co., Ltd., China. The ore is of low lead grade (approximately 1.3%). The results of the chemical analysis are shown in Table 1. A quantitative mineralogy determination using X-ray powder diffraction (XRD) and mineral liberation analyzer (MLA) were done by the analytical laboratory and the results indicated that the main valuable minerals are galena, sphalerite and the gangue minerals are pyrite, quartz and calcite (Table 2). According to this result, the flotation flowsheet and the reagents can be determined.

The reagents used were: depressant (Lime, Zinc sulfate and Sodium silicate), collector (Diethyldithiocarbamate; Ammonium butyl aerofloat; Potassium butylxanthate and Thiamine ester) and frother (Methyl isobutyl carbinol).

### 2.2. *Methods*

#### 2.2.1. *Grinding*

Ore samples were crushed to −2 mm, riffled into representative samples of 500 g, purged with nitrogen during storage. For each flotation experiment, samples were ground in a mild steel rod mill for a certain time. Lime, as pH regulator was added at the grinding stage.

#### 2.2.2. *Flotation*

As shown in Fig. 1, the flotation tests were performed in a XFD-63 flotation cell (self aeration) whose volume for flotation was 1.5 L using an agitation speed of 1800 rpm. The solid density in the flotation cell was changed according to the experimental requirements. During the conditioning,

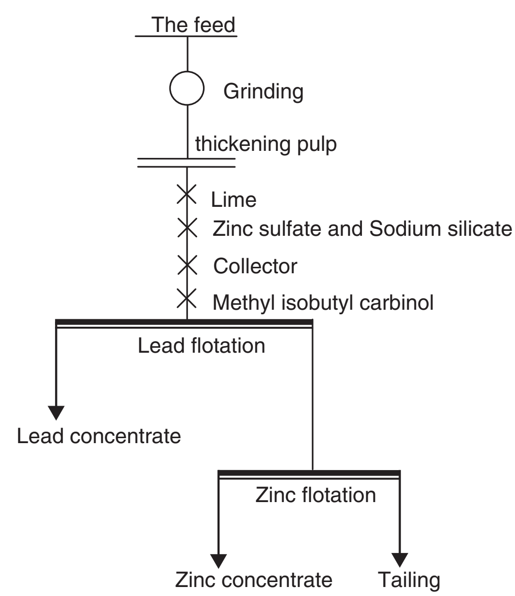


**Fig. 1 – The flowsheet of flotation tests.**

depressant (Zinc sulfate and Sodium silicate), collector and frother (Methyl isobutyl carbinol) were added and conditioned for 5 min, respectively, to allow reagent adsorption. After the conditioning time, the flotation of lead minerals started with the injection of air in the flotation cell, the air flow rate was kept at 0.1 $Nm^3/h$ monitored with a flow meter. Flotation was performed for 5 min and the concentrate was collected. In this paper, only the flotation of lead minerals was shown.

## 3. Results and discussion

As most minerals are finely disseminated and intimately associated with the gangue minerals, they must be initially liberated before separation can be undertaken [8–10]. The effective liberation of lead minerals is the foundation of separating lead minerals. Thus, the effect of grinding time on lead mineral flotation was investigated and the results are shown in Fig. 2. The grinding pulp density was about 66%. The detailed flotation experimental conditions are as follows:

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