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Bioleaching of sphalerite by the native mesophilic iron-oxidizing bacteria from a lead-zinc tailing

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Abstract

An isolated native mesophilic iron-oxidizing bacteria, acidithiobacillus ferrooxidans, was used to extract zinc by the bioleaching method from a typical lead-zinc tailing. Experiments were carried out by mixed culture of the mesophilic strain in the shake flasks and the different influencing factors such as pH, temperature, inoculation cell number, as well as slurry concentration on the process of bioleaching were investigated. The results indicated that the extraction efficiency of zinc was relevant with these variables and more than 70% of sphalerite was dissolved on the condition of with pH 2.0, initial ferrous concentration of 10 g/L and slurry concentration of 10wt.% during 25 d, while without bacteria, 22% of Zn was merely extracted.

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Keywords: Acidithiobacillus ferrooxidans; bioleaching; lead-zinc tailing; sphalerite

1. Introduction

As the solid wastes formed by natural dehydrated slurry after mineral separation, lead-zinc tailing usually contains large amount of heavy metals and other toxic substances which will threaten the local environment and impact on the sustainable development of ecosystem[1-2]. Therefore, it is significant to develop simple and environmental-friendly methods to reuse and reducing toxicity of the industrial wastes. Bioleaching is an alternative to traditional physical-chemical methods based on the oxidation of acidophilic bacteria which has the ability to derive the energy from the oxidation to meet with the growth and other metabolic functions of bacteria[3-4], and has gained importance for the extraction of metals particularly from the difficult-to-treat and low grade ores[5-6]. The

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mechanism can be generally described as follows. During the oxidation of ferrous iron and elemental sulphur with bioleaching process, the reaction energy can be utilized by the acidophilic bacteria which are required for their growth and other metabolic functions (Eq.(1) and(2))[7]. In another word, the bacteria make use of the iron cycle at low pH where the initial ferrous ions were served as electron donor and the ferric irons were used in place of oxygen as an electron acceptor by the sulfur-oxidizing organisms[8]. Meanwhile, the derived products, ferric iron and/or acid, will attack the sphalerite ores and lead to their dissolution (Eq.(3) and(4))[9].

$$2Fe^{2+} + 1/2\ O_2 + 2H^+ \longrightarrow 2Fe^{3+} + H_2O \quad (1)$$

$$1/8\ S_8 + 3/2\ O_2 + H_2O \longrightarrow 2H^+ + SO_4^{2-} \quad (2)$$

$$ZnS + 2Fe^{3+} \longrightarrow Zn^{2+} + 2Fe^{2+} + S \quad (3)$$

$$ZnS + 2H^+ \longrightarrow Zn^{2+} + H_2S \quad (4)$$

In this study, a native microorganism, acidithiobacillus ferrooxidans, is applied to the bioleaching process of zinc extraction from a local deposit in southern region of Shaanxi province in China containing sphalerite tailings grading nearly 2.3% zinc. The flask tests were done, followed by continuous analytical tests. In addition, some significant factors, such as the effect of residence time, slurry concentration and inoculation cell number on the bioleaching performance were studied under the optimum condition of experiments.

2. Results and discussion

2.1. Mineral characteristics

A representative was obtained from the lead-zinc tailing ore and the cumulative passing fraction of the particles was tested by means of cyclosizer. It found that about 48.2% of core samples was 100 to 80 μm in size (Fig. 1), and was finally ground to particles with size of less than 0.5 μm. Over 80% of the mineral had a particle size of 0.08 μm for the experiment of flask tests.

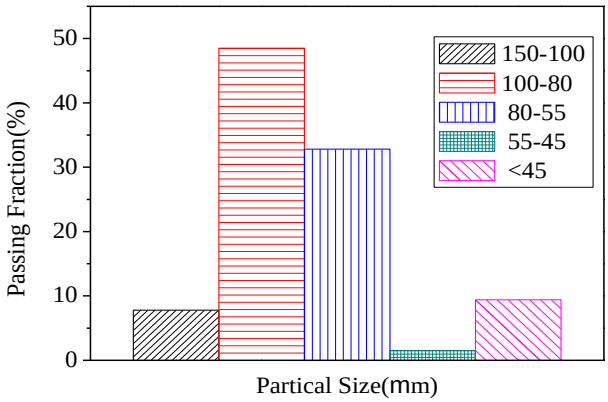

Fig. 1 Size distribution of tailings

Chemical compositions of the sample are presented in Table 1. The X-ray diffraction analysis showed that quartz was the dominate mineral in sample, and chlorite, along with sphalerite as the minor phases.

Table 1. Chemical compositions of the tailings

Zn	Fe	Pb	Cu	SiO_2
2.27	14.92	0.95	0.04	44.54
Al_2O_3	CaO	MgO	MnO	SO_3
12.56	4.18	3.59	1.23	5.04