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Review Article

Effect of calcium ion on the separation of rhodochrosite and calcite

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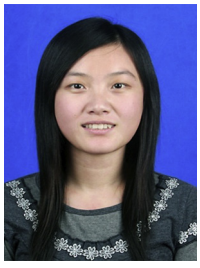
ABSTRACT

The effect of calcium ion on the separation of rhodochrosite and calcite was systematically investigated based on flotation tests, zeta potential measurements, and scanning electron microscopy analysis. The flotation results showed that the separation of rhodochrosite and calcite was inefficient due to rhodochrosite and calcite being similar in many physical and chemical properties, which could make the separation of rhodochrosite from calcite inefficient. The separation of rhodochrosite and calcite can be significantly improved by adding sodium hexa metaphosphate (SH) because SH could depress calcite flotation while it did not bring an impact on rhodochrosite flotation. However, when calcium ion was added into this flotation system, the separation of rhodochrosite and calcite deteriorated as SH also depressed rhodochrosite flotation under this condition. The solution chemical calculation and scanning electron microscopy analysis illustrated that the formation of calcite precipitation coated on the rhodochrosite surface was the main reason because calcium ion increased the depression effect of SH on rhodochrosite.



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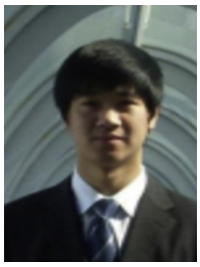

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1. Introduction

As the primary source of manganese, pyrolusite is steadily getting depleted and rhodochrosite ($MnCO_3$) becomes one of the major sources of manganese oxide. Although manganese carbonate resources are very rich in China, there are fewer and fewer high-quality resources due to the over-exploitation of manganese ore. To meet manganese market demand in the future, it is significant to develop low-grade rhodochrosite for a marketable product. Especially, the flotation is one of the most effective methods to increase the recovery of fine grained and low-grade rhodochrosite.

Calcite is one of the most common and important components in sedimentary rocks. And calcite is an extensive carbonate gangue in the flotation of rhodochrosite, smithsonite, celestite and apatite [1–3]. It is easy to enter the rhodochrosite flotation concentrate because of naturally hydrophobic, thus reducing concentrate grade [4]. Being a calcium type gangue mineral, large quantities of calcite in flotation concentrates can cause problems during smelting. Rhodochrosite and calcite are calcite-group minerals that show similar flotation behavior due to the same crystal structure and similar chemical composition. Therefore, it is difficult to achieve effective separation of rhodochrosite from calcite in conventional flotation. Flotation separation of valuable carbonate minerals and calcite is extremely complex because of the interaction between minerals and dissolved metal ions.

The dissolution characteristics of rhodochrosite and calcite play an important role in determining the interactions occurred in the bulk solution or on the mineral surfaces [2,5]. The dissolved species of minerals could participate in some reactions such as hydrolysis, complexation, adsorption, and bulk precipitations, which could affect the selective interaction between reagent and mineral [6–8]. In addition, some agents such as CaO, which is used as pH regulator and the water used in actual production also increase the content of the cations, which also effect rhodochrosite flotation in the pulp. Although some reagents such as starch, sodium hexa methaphosphate (SH), and sodium silicate are usually used as calcite depressants in rhodochrosite flotation, the separation process shows relatively low selectivity in practice due to their similar surface properties and dissolved species [9–11]. Moreover, few literatures are focused on the effect of metal ions on flotation separation of rhodochrosite and calcite.

In this study, the effect of calcium ion (Ca^{2+}) on the separation of rhodochrosite and calcite was investigated. The flotation tests were used to examine the flotation regularity of rhodochrosite and calcite in the absence and presence of Ca^{2+}. To clarify the reasons on the difficulty in flotation separation of rhodochrosite and calcite, the electro-kinetic zeta potential measurements, solution chemistry calculations, scanning electron microscopy, accompanying with the flotation results, were systematically carried out.

2. Experimental

2.1. Samples and reagents

Both calcite and rhodochrosite used in this study were obtained from Changsha, Hunan Province, China. The results of mineralogy and X-ray powder diffraction confirmed that the purity of both samples was higher than 95%. The obtained samples were ground and then sieved to collect the −100 μm fraction for the microflotation and scanning electron microscopy tests. Hydrochloric acid (HCl) and sodium carbonate (Na_2CO_3) were used as pH regulators. Sodium oleate (NaOL) and sodium hexametaphosphate (SH) were used as collector and depressant, respectively. Calcium chloride ($CaCl_2$) was dissolved to prepare a predefined concentration of Ca^{2+} solution. All the reagents used in this study were of analytical grade. The water used in actual production has a certain degree of hardness. A certain amount of calcium and magnesium ions in water, which also affect the flotation separation of rhodochrosite and calcite. In order to eliminate the effect of ions in water on rhodochrosite flotation, for researching convenience, deionized double distilled water was used for all tests.

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