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Technical Note

Study on sulphidization roasting and flotation of cervantite

Jinming Wang [a], Yuhua Wang [a,*], Shilei Yu [b], Fushun Yu [a]

[a] School of Minerals Processing and Bioengineering, Central South University, Changsha 410083, China
[b] Tianjin Huakan Mining Investment Co., Ltd., Tianjin 300170, China

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ABSTRACT

A new technology, sulphidization roasting of antimony mineral cervantite with elemental sulfur followed by froth flotation is reported in this paper. The effects of roasting temperature and time, sulfur to antimony molar ratio on the properties of treated product and its flotation behavior were studied. Optimum roasting conditions are: roasting temperature 723 K; roasting time 30 min; and sulfur to antimony molar ratio of 1.5. Under these conditions, the mineral phase changed from cervantite to stibnite as expected. The flotation recovery of the sulphidized cervantite is over 90%. A flotation concentrate grading 21.04% Sb with a recovery of 77.15% is achieved by sulphidization roasting and flotation from a feed grading 1.11% Sb in which cervantite is the main antimony mineral.

1. Introduction

Antimony is an important strategic resource; widely used in printing, batteries, alloying, military industry and other fields (Anderson, 2012). Antimony, is primarily extracted from antimony sulfide ores, such as stibnite (Lager and Forssberg, 1989a,b), jamesonite (Lager and Forssberg, 1989a,b) and as a byproduct in lead smelting. Primary sulfide antimony resources are insufficient to satisfy industrial demand. The utilization of antimony oxide ore to satisfy industrial demand is now being considered. Cervantite (Sb_2O_4) is an important antimony oxide resource. The literature on the flotation treatment of cervantite (Xiao et al., 1987) indicates poor recovery from the direct flotation of oxide ores. Sulphidization of oxide minerals of zinc and lead for recovery as synthetic sulfides using conventional froth flotation is well known (Song et al., 2001; Kazutoshi et al., 2012).

However, no work reported on sulphidization of antimony oxide ore. In this study, antimony oxide ore was sulfurized with the elemental sulfur by roasting. During the sulphidization roasting pretreatment, cervantite is partially transformed into stibnite, which can easily be separated by conventional flotation techniques.

2. Experimental

2.1. Materials

Bulk samples containing cervantite were obtained from the Xikuangshan Mine located in China. Bulk samples were crushed by hammer, and high purity cervantite crystals were manually separated under a microscope. Cervantite samples were dry-ground in a porcelain ball mill and wet-screened in distilled water to obtain a −0.074 + 0.038 mm size fraction. The XRD pattern results in Fig. 1 show that the cervantite content of the sample is 90.81%.

Antimony oxide ore samples with an antimony grade of 1.11% were taken from the flotation tailings of the Xikuangshan Mine. The results of XRD are shown in Fig. 2. Cervantite, quartz, calcite, mica, kaolinite and montmorillonite are the major minerals.

Element sulfur (>99%, powder) was used as the sulphidizing agent. Industrial amyl xanthate and butylamine aerofloat were used as collectors, lead nitrate was used as activator and pine oil was used as frother for the flotation of the sulphidization treated products.

2.2. Sulfidation roasting tests

Two grams of cervantite was mixed with elemental sulfur in various ratios, and loaded into a tightly sealed 10 ml crucible, and then placed inside a 50 ml crucible. The gap areas were filled with coal powder to keep a reducing atmosphere. The 50 ml crucible was put into a muffle furnace and treated under the different experimental conditions. The treated product was cooled to room temperature in air prior to flotation. The sulphidization roasting procedure for ore samples was the same as single mineral, the difference was just the volume of crucible.

2.3. Flotation tests

Flotation tests on the treated product of single mineral were carried out in a 40 ml flotation cell, 2 g of samples, prepared under

* Corresponding author. Tel.: +86 731 88830545; fax: +86 731 88710804.
E-mail address: wangyh@csu.edu.cn (Y. Wang).

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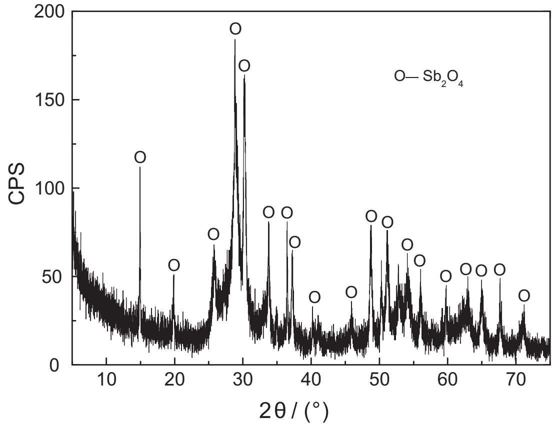

Fig. 1. The XRD pattern of cervantite.

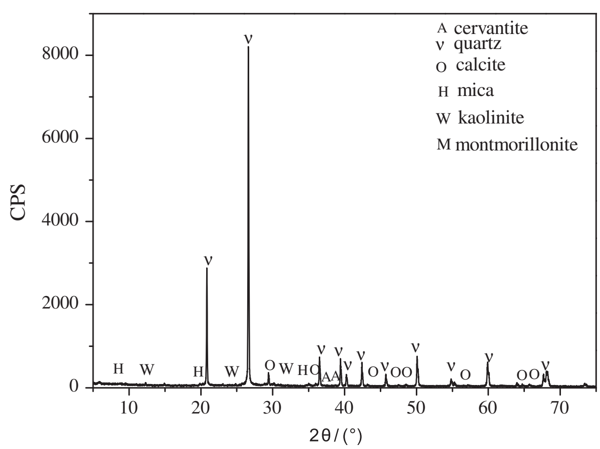

Fig. 2. The XRD pattern of antimony oxide ore.

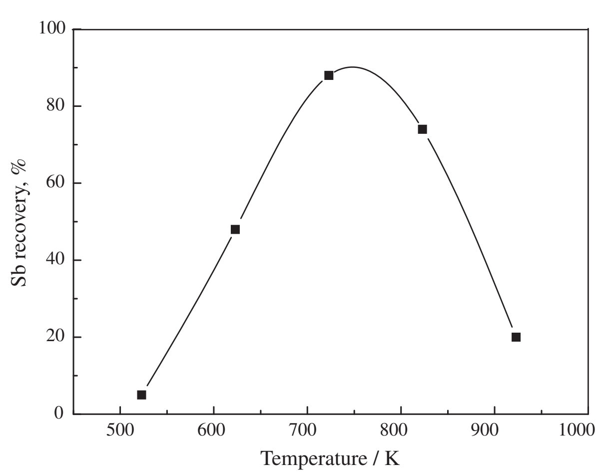

Fig. 3. Effect of temperature on flotation recovery of sulfidation roasted products. Roasting conditions: 30 min, sulfur to antimony molar ratio of 0.9.

different sulphidization roasting conditions, were used for flotation each test. After the desired amounts of reagent were added, the pulp was agitated for three minutes and floated for three minutes. The froth and tailing products were filtered, dried, and weighed for the calculation of mineral flotation recovery. Tests on the ore sample used a 1-L flotation cell.

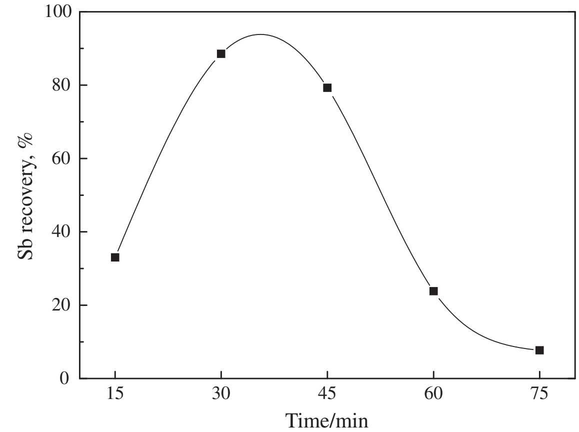

Fig. 4. Effect of roasting time on flotation recovery of sulfidation roasted products. Roasting conditions: (723 K, sulfur to antimony molar ratio 0.9).

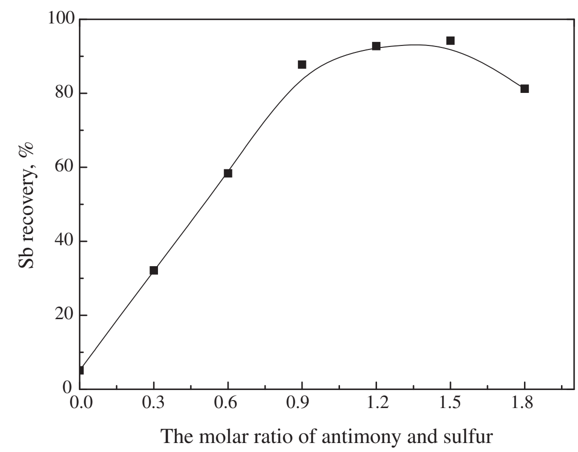

Fig. 5. Effect of sulfur to antimony molar ratio on flotation recovery of sulfidation roasted products. roasting conditions: (723 K, 30 min).

Table 1
Effects of temperature on the components of sulfidation roasted products.

Temperature (K)	Compositions
523	Sb_2O_4, S
723	Sb_2O_4, Sb_2S_3
923	$Sb_2O_{3(C)}$

Table 2
Effects of roasting time on the components of sulfidation roasted products.

Time (min)	Compositions
15	Sb_2O_4, S, Sb_2S_3(less)
30	Sb_2O_4, Sb_2S_3(more)
60	$Sb_2O_{3(C)}$, $Sb_2O_{3(O)}$,

2.4. Analyzing on treated and flotation products

A Shimadzu D/MAX-rA X-ray diffractometer and a JSM-6490LV scanning electron microscopes (SEM) were used in this study to analyze test products.