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Effect of milling on metal leaching: induction of galvanic effect in a secondary lead smelter matte by prolonged milling

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Abstract

The effect of milling on the leaching of Pb (and other metals like Fe, Cu, Ni and Zn) from a secondary lead smelter matte was studied. The effects of milling time, milling environment (dry or wet milling) and leaching reagent (Fe(III)-HNO₃ or citrate solution) on the leaching efficiency of metals were investigated. A 1-2 mm ferromagnetic fraction of the matte, containing 54% Fe, 5.8% Pb, 24% S and minor levels of Cu (1.2%), Ni (0.2%) and Zn (0.3%), was used. Pb leaching in a Fe(III)-HNO₃ solution was enhanced from 53% (no milling) to 85% after 5 minutes of dry milling. Prolonged milling resulted in an agglomeration of particles causing a galvanic effect (between FeS and Pb), which led to electrochemical precipitation of Pb²⁺ cations from the solution as PbS. Because of this electrochemical precipitation, almost no Pb²⁺ was detected in the Fe(III)-HNO₃ solution after 10 minutes of dry milling. In order to avoid/reduce agglomeration and to obtain a finer particle size and higher leaching efficiencies, wet milling was carried out. The highest Pb leaching was obtained after 20 minutes of wet milling (88% in the Fe(III)-HNO₃ and 94% in the citrate solution). Citrate solution was more selective towards Pb leaching, with < 2% Fe leaching from the matrix material compared to 20-24% in the Fe(III)-HNO₃ solution. The optimised milling and leaching steps were combined to attain a process for the selective recovery of valuable metals from secondary lead smelter matte.

Keywords: lead recycling; matte; leaching; milling; galvanic effect

1. Introduction

Secondary lead production accounts for more than 60% of the total lead produced worldwide. Used lead-acid batteries (ULABs) are the main source for secondary lead production, representing more than 85% of the total amount of secondary lead [1]. Although the lead recycling industry represents a good example of a closed material loop, it also generates a significant amount of residues. Since most lead recycling facilities use pyrometallurgical processes, emissions of sulfur oxides and solid lead-bearing residues are the main by-products [1]. As these solid residues still contain lead, they present both an environmental hazard and a potential loss of valuable metals [2-4]. The sulfur oxides emissions can be captured by calcium based sorbents [5] or treated to produce sulfuric acid [6]. The main lead-bearing solid residues generated during recycling of ULABs consist

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