USE OF BIOREACTORS IN THE LEACHING OF AN OXIDIZED COPPER ORE

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***Abstract*— Copper recoveries using two methodologies of acid leaching of a low-grade ore are reported in this work. The ore, abounding in oxidized species, was from Barda González reservoir in Neuquén province, Argentina. In the first methodology, cells of *Acidithiobacillus thiooxidans* were inoculated into a column containing the ore and sulfur as energy source. In the second one, a bioreactor with immobilized cells of *Acidithiobacillus thiooxidans* placed on small pieces of elemental sulfur was used to generate acid medium. This medium was then transferred to another column containing the ore. In the first methodology low cell counts and also low copper recovery were obtained. However, in the other, about 56 % of copper was recovered after four loads of fresh medium.**

***Keywords*— Bioreactors, copper, oxidized ore, *Acidithiobacillus thiooxidans*.**

I. INTRODUCTION

Acidithiobacillus thiooxidans (*A. thiooxidans*) is a chemolithotrophic bacterium frequently associated with sulfide ores. It plays a major role in metal solubilization processes from minerals, in a direct or indirect way, together with another microorganisms (Rawlings, 1997). This bacterium is able to catalyze the oxidation of reduced inorganic sulfur compounds using oxygen as the terminal electron acceptor. Elemental sulfur can be also used as substrate (Gourdon and Funtowicz, 1998; Konishi *et al*., 1995) according to the following process:

$$S + 3/2\ O_2 + H_2O \longrightarrow H_2SO_4 \qquad (1)$$

Precisely, the previous equation probably shows the most significant contribution of this bacterium to the solubilization of metals, specially when they are associated with oxidized species easily assailable through acid leaching (Bhatti *et al.*, 1997; Donati *et al.,* 1995*)*.

Sulfuric acid can be continuously produced in bioreactors with *A. thiooxidans* where the cells are attached to elemental sulfur (Donati *et al.*, 1995; Pich Otero *et al.*, 1995).

The aim of this work was to study the sulfuric acid production in a bioreactor with immobilized *A. thiooxidans* cells and the use of this acid in the leaching of an ore. The mineral is from Neuquén province and its copper content is present mainly as oxidized compounds easily solubilized by low-concentration acid solutions.

II. METHODS

Culture

A. thiooxidans DSM 11478 routinely cultured at 30 °C in 9 K medium (Silverman and Lundgren, 1959) without ferrous sulfate, named 0 K, with sulfur as energy source, was used in all experiments.

Sulfur Bioreactor

Bioreactors were flooded columns of 29 cm height and 4 cm diameter, containing 300 ml of 0 K medium adjusted to pH 5.0 and 100 g of sulfur (particle size about 1-2 mm). Cultures of *A. thiooxidans* were harvested in exponential growth phase and used as inoculum. Air was continuously fed to the solution at a flow of 2.5 VVM (air volume/liquid volume/minute). When the pH about 1.0 was reached, the liquid into the reactor was replaced by the same volume of fresh medium, without new inoculation. The bioreactor was loaded five times in order to reach a constant sulfuric acid production (five steps of biofilm generation). During these growth phases, pH, proton concentration and bacterial numbers in suspension were determined. Scanning electron micrographs of the cells were taken in a Philips 515 equipment. A drop of liquid culture was dried