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Advancements in Anode Slimes Treatment: Efficient and Sustainable Selenium Recovery through Alkaline Leaching

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Extended Abstract

Anodic slimes are a by-product of the copper electrorefining process, which have a high commercial value because they contain significant amounts of Au and Ag, as well as Cu, As, Se, Te and platinum group metals. These compounds vary from one refinery to another, depending on the composition of the anode. The anode slimes are periodically collected from the bottom of the electrolytic cell, they are processed for recovery of metals of interest, such as Cu, Au, Ag, Se and Te [1-2]. The most important motivation for the anode slimes treatment is to recover Au and Ag. To achieve this, pre-treatments for Cu, Te, and Se recovery are necessary. In the case of selenium, it is more than a pre-treatment, since it is the main source to obtain this element, since about 90% of selenium is obtained from treating copper anode slimes [3-8].

In recent years, anode slimes treatments have experienced multiple changes, this is the reason why there are two treatment routes: the traditional one via pyrometallurgical processes and an alternative route through hydrometallurgical treatments, that partially replaces the traditional route [7, 9-10]. This is why the interest arises in evaluating a hydrometallurgical treatment for the dissolution of selenium to diversify high-value metal products while minimizing environmental impact.

In order to replace the traditional process with a low impact on the environment, it is proposed to evaluate an alternative process to those currently used. This proposal will partially replace the traditional process through an alkaline leaching in an oxidizing medium (OCl^-/OH^-), which will allow a good handling of solutions with selenium content, compared to the pyrometallurgical process.

In order to achieve the stated objective, it is important to carry out the characterization of anode slimes by atomic absorption spectroscopy (AAS), X-ray diffraction (XRD), scanning electron microscopy (SEM) with Energy-dispersive X-ray spectroscopy (EDS) and determination of particle size. Experiments of oxidizing leaching of anode slimes were carried out using the experiment design method. To evaluate the progress of the selenium leaching process reaction from anode slimes, the effect of variables such as pH, temperature, and concentration of the oxidizing reagent was evaluated. To identify the optimal combination of process variables, the Anova Analysis was used, evaluating three parameters and three levels at a constant stirring speed. The residue resulting from the leaching was characterized by SEM/EDS. The latter allowed the determination of the product compounds from the leaching process. In order to analyze the contribution of each of the variables and the optimal parameterization in the objective parameter (selenium dissolution), the results were analyzed using ANOVA. The results have indicated that optimal selenium dissolution, reaching approximately 90%, can be achieved under moderate conditions of pH, temperature, and (OCl^-/OH^-). According to the SEM/EDX characterization of the solid leaching residue, the undissolved percentage of selenium is due to the generation of a layer of AgCl around the selenium particles that hinders the effective diffusion of the reagent. Results demonstrate the feasibility of sustainable selenium extraction from anode slimes by alkaline leaching.

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