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INTRODUCTION

Dear Distinguished Delegate,

The second edition of the International Conference on Advances and Innovations in Engineering (ICAIE) was held between 21-23 September 2023 at Fırat University Faculty of Engineering, Elazığ.

International Conference on Advances and Innovations in Engineering is an international scientific forum of distinguished scholars engaged in scientific, engineering and technological research, dedicated to the furtherance of science, engineering and technology. The academic research conference since its inception is at the cutting edge of international nonprofit scientific, engineering and technological progress to promoting excellence in science.

The conference plays an influential role in science and promotes developments in science, engineering and technology in a wide range of ways. The conference aims to foster research in the area of science and technology and its impact to mainstream human activities. Specifically, it serves as a venue for discussions and exchange of ideas in current issues in science and technology.

All full paper and abstract submissions to the conference are peer reviewed and refereed and evaluated based on originality, research content and correctness, relevance to contributions, and readability. In this content the full paper and abstract submissions are chosen based on technical merit, interest, applicability and how well they fit a coherent and balanced technical program. The accepted papers after rigorous peer reviewing process have been published in the refereed international conference proceedings

Chair of ICAIE Committee
Prof. Ebru AKPINAR

CONTENTS

Apply the copper anodes of non-standard chemical composition for sulphur acid waste solution electrolytical treatment

Radmila Markovic[1], Bern Friedrich[2], Dragana Bozic[1], Zoran Stevanovic[1]

[1]Mining and Metallurgy Institute Bor, Bor, Serbia
[2]Process Metallurgy and metal Recycling (IME), RWTH Aachen University, Aachen, Germany

Abstract

For more than a century, electrolytic refining is the main process for obtaining copper whose physical and chemical properties meet strict requirements for application in electronics, electrical engineering, energy, microelectronics. The accumulation of impurities such as nickel, arsenic, iron, antimony, leads to changes in the chemical composition of the electrolyte as one of the basic parameters in the process of copper cathodes obtaining. At the same time, due to a sudden increase in demand and reduction of copper content in the ores, secondary materials are increasingly being used to commercial copper anode production.

The copper anodes of non-standard chemical composition (high contents of Ni, Pb, Sn and Sb) are examined for electrolytic treatment of the waste sulphur acid solutions. These solutions originated from the commercial electrolytic copper refining processes. As well as the high concentration of Cu ions, these solutions contain high concentrations of Ni and As ions. The investigations were focused on the anode passivation behaviour, changes in the chemical composition of the solution, obtaining the cathode deposit and anode slime. Components for the anodes preparing were selected on the basis of literature data for the chemical composition of the anodes obtained from the secondary materials and the behaviour of impurities in the copper refining process. Nickel content had a constant value of 5 or 10 mass %, whereas the content of Pb, Sn and Sb was in range from 0.1 to 1 mass% per item. Different combinations of these values were used for anodes preparation.

Electrochemical measurements that were performed on laboratory type equipment, applying the method of anodic linear sweep voltammetry (ALSV), were used for preliminary investigations of anodes dissolution in acidic solution. The passivation peaks are registered on all voltammograms, but the values of the potential and current density were different. Comparing the results for series of anodes with the same nickel content (5 or 10 mass % Ni), it was found that anodes with a higher content of impurities (Pb+Sn+Sb mass %) were entering in the passive area at lower current density. The results confirmed that the copper anodes with high content of Ni, Pb, Sn and Sb could be refined in galvanostatic conditions at current density which value is characteristic for the commercial process. Investigations of the electrolytic treatment of the real waste sulphur acid solution with high content of Cu, Ni and As, at current density whose value is within commercial value, were carried out on the large-scale equipment. Refining of copper anodes was performed with constant galvanostatic pulse (25 mA/cm2), at two different temperatures (T1 = 63 ± 2 °C and T2 = 73 ± 2 °C) during the 72 h, the weight of each anode was about 7 kg. Based on the change of cell voltage value, which is measured and recorded by every 10 s for 72 h, it was found that all the anodes are dissolved during the process. Changing the cell voltage was carried out in several characteristic phases. The results showed that no one of the anodes is permanent passivated. In many numbers of the anodes, the passivation is appeared for a few minutes to a maximum of 40 minutes, but the anodes were reactivated after this time and continue to dissolve. The appearance of the stable and oscillatory phase was registered for the all anodes. At the anodes with 5 mass % Ni, the peak of passivation phenomenon was observed in 75 %, and in the anodes of the 10 mass % Ni, in 12.5 % of the total number of anodes.

The analysis of the concentration of Cu and Ni ions in solution showed that the Cu ions concentration decreases and the Ni concentration increases. Maximum concentration of Cu ions is reduced to about 3 % and the concentration of Ni ions maximized to 150 % of the respective baseline values. The decreasing of copper ions concentration was

[1]Corresponding author

confirmed that along with the process of electrolytic refining of anodes occurs the electrowinning process. That is confirmed by the data for the cathode deposits mass, which for all anodes and both temperatures were the higher than mass of copper that dissolve from the anodes. For a many numbers of anodes, cathode mass of deposit is greater than the theoretical values of the Cu mass that can precipitate at working current density. The different temperatures of the solution have no influence on the composition of the electrolyte. The investigation of the changes the arsenic ions concentrations has shown that the arsenic concentration was decreased compared to baseline value. The concentration of tin ions at the end of each experiment was greater than the baseline. During the first 24 h concentration changing was the highest, and in the continuation of the process the concentration changing varied from anode to anode. Changing the concentration of antimony in the first 24 h had an upward trend compared to the baseline value. The concentration of antimony is changed up to the end of the tests but there was no proper dependency. The analysis of the anode slime chemical composition was confirmed that the next elements are present in the slime: Pb, Sn, Sb, As, Ni and Cu. Based on the data of the anode slime mass and the weight of dissolved anodes, it was found that the percentage of anode slime is higher for the anodes with a higher content of Pb+Sn+Sb, at lower temperature. The minimum value of 0.58 % is obtained by refining the anode with 10 % Ni and 0.305 % Pb+Sn+Sb. The physical appearance and weight of cathode deposits have confirmed that during the treatment, two processes are conducted: electrorefining and electrowinning.

Keywords: anode, copper, nickel, lead, antimony, tin