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Recovery of Copper from Strong Chloride-based Solution

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Abstract: Strong chloride-based copper solutions were investigated for copper recovery by using aluminium scraps. From the recovery process, the reaction rate is consistently to be first order to cupric ion. The activation energy for the process calculated from the Arrhenius plot indicates a chemical controlled process. The immersion of aluminium scraps into prepared cupric and cuprous solutions created a clean and depressed aluminium surface morphology. It is found that cuprous solution cements higher purity of copper than cupric solution. The aluminium scrap surface area also contributes to the purity of cemented copper. For a sample of copper bearing spent etching bath containing 131.6 g L^{-1} copper, more than 99% copper was recovered with 94.4% purity.

Key words: Copper recovery, aluminium, chloride, cementation

INTRODUCTION

The cementation or metal displacement reaction is an electrochemical process by which a more noble metal ion is precipitated from solution by a metal higher in the electromotive series. Several hydrometallurgical processes have been developed for the separation of metals from their spent solution. The electrolytic extraction process has been used in the precipitation and purification of metal. Although the electrolytic recovery of metal from dilute solutions is of considerable importance, there are a number of objections to electro-winning as a means of copper recovery from solution. Its operating, investment and energy costs are rather high. In addition, the acid streams formed at the anodes reduce quality of the products obtained[1].

Cementation is still an important reaction in hydrometallurgical processing. It is very fast and probably controlled by the rate at which the ions diffuse to and from the metal surface. It is a quick and cost saving method to recover copper from a variety of leach solutions[2-4]. Won *et al.*[5] and Tadeusz *et al.*[6] reported on the recovery of copper from such solutions by using iron scrap. The kinetic of copper deposition from a low concentration solution onto zinc was described by Strickland and Lawson[7]. Masse and Piron[8] studied the cementation of copper from an alkaline solution in their simulation work.

Cementation of copper onto aluminium[9,10] has been studied extensively in relation to their solution composition. Its process kinetics[11-15] indicated the reaction to be first order in nature. The overall reaction can be expressed as Eq. 1. The utilization of aluminium scraps in the cementation process would help to solve the ecological problem in waste-littering. In addition, it is an economical usage of aluminium waste compared to the cost of energy in reclaiming aluminium metal[16-19].

$$3Cu^{2+} + 2Al \rightarrow 2Al^{3+} + 3Cu^{\circ}\ E^{\circ} = +1.997V \quad (1)$$

Annamalai and Murr[9] reported that the present of chloride could leach away aluminium oxide surface. A minimum of 25 mg L^{-1} chloride was required to provide effective active surface area but the aluminium surface became porous at higher chloride concentration. In the present investigation, an attempt has been made to evaluate the cementation behaviour of copper in strong chloride media by using aluminium scrap. An effort is also made to associate some critical solution factors in the recovery process.

MATERIALS AND METHODS

Materials: All experimental solutions were prepared from analytical grade chemicals and distilled water. Cuprous chloride stock solution was prepared by dissolving exact amount of pure copper bar in 0.05 M cupric chloride,

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