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OXIDATION OF FERROUS AND CUPROUS SPECIES IN OXYGENATED CHLORIDE SOLUTIONS: A KINETIC MODEL APPROACH

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ABSTRACT

Chloride leaching with Cu (II) offers an attractive alternative for the treatment of pyritic/arsenopyritic refractory gold ores because the liberation and dissolution of gold locked in the sulphides can be achieved in a single-stage process. Currently, this process is already used in the leaching of copper sulphide ores.

In oxygenated chloride solutions containing copper, Cu (II) species is the main sulphide oxidative agent and may be continuously regenerated by the oxidation of the formed Cu (I) species with oxygen. However, during the leaching of the refractory gold ores, the chloride solution accumulates iron and sulphate species produced by sulphides dissolution, which may affect the regeneration of the Cu (II) species and its oxidizing power. Therefore, a good understanding of the interaction of copper (Cu (I) and Cu (II)) and iron (Fe (II) and Fe (III)) species is necessary to describe the oxidation kinetics in this complex solution environment.

In this work, oxidation experiments were conducted at 75ºC in 0.5 L solution containing 4.0 M NaCl and 0.1 M HCl for 10 h. Cu (I) oxidation experiments were performed in the presence of Cu (II), SO_4^{-2}, Fe (II) and Fe (III) species, while Fe (II) oxidation experiments were performed in the presence of Fe (III), Cu (II) and Cu (I) species. All experiments were conducted stirring at 450 rpm and bubbling air at 3.5 L/min.

The oxidation results showed that Cu (I) oxidation with air was affected by Cu (II), SO_4^{-2}, Fe (II) and Fe (III) species. Likewise, the Cu (II) regeneration with air was slower as the Fe (II) concentration increased at the beginning of the process. Concerning the Fe (II), its oxidation with air was affected by Fe (III) species; however, the presence of Cu (II) and Cu (I) species improved the rate of Fe (II) oxidation. On the other side, the mechanism proposed for interactions of Cu (I), Cu (II), Fe (II), and Fe (III) species in aerated chloride solutions was according to a stepwise reaction kinetics and considered important thermodynamic aspects, so each half-reaction could occur spontaneously in aerated chloride solutions.

The kinetic model developed from this mechanism may predict the concentration of Cu (I), Cu (II), Fe (II) and Fe (III) in aerated chloride solutions satisfactorily. This kinetic model adequately responded to different compositions of chloride-leaching solutions in terms of the concentrations of Cu and Fe species. The model predictions agreed well with the experimental data over the range of conditions tested.

Keywords: Cu(I) oxidation, Fe (II) oxidation, Chloride leaching, Refractory gold ores, Copper sulphides.