

THE KINETICS OF THE DISSOLUTION OF CHALCOPYRITE IN CHLORIDE MEDIA

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DECLARATION

I declare that this thesis is my own account of my research and contains as its main content work that has not previously been submitted for a degree or examination at any tertiary education institution.

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_____ Day of _____ 2009

ABSTRACT

One of the most important outstanding problems with the hydrometallurgy of copper is the low temperature leaching of chalcopyrite. In this thesis, a fundamental study at low temperature was undertaken in order to establish a mechanism, which is consistent with the data obtained in an extensive study of the kinetics of dissolution of several chalcopyrite concentrates.

It will be demonstrated that enhanced rates of dissolution can be achieved at ambient temperatures by the application of controlled potentials in the range 560-650 mV, depending on the concentration of chloride ions. However, control of the potential by the use of electrochemical or chemical oxidation of iron(II) or copper(I) ions is ineffective unless carried out in the presence of dissolved oxygen. The rates of dissolution are approximately constant for up to 80% dissolution for sized fractions of the concentrates with an activation of energy of about 75 kJ mole^{-1} . Chalcopyrite from different sources appears to dissolve at approximately the same rate which is largely independent of the iron and copper ion concentrations, the acidity and chloride ion concentration but depends in some cases on the presence of additives such as fine pyrite or silver ions.

Based on the results of these leaching experiments and detailed mineralogical analyses of the residues, a mechanism involving non-oxidative dissolution of the mineral coupled to oxidation of the product hydrogen sulfide will be proposed. The latter reaction is shown to occur predominantly by a copper ion – catalyzed reaction with dissolved oxygen. The results of an independent study of the kinetics of this reaction will be presented which will demonstrate that the rates are consistent with those obtained for the dissolution of the mineral. The possible involvement of a covellite-like surface layer on the chalcopyrite under some conditions will also be discussed as it relates to the mechanism. It will also be shown that fine pyrite particles can also act as a catalyst surface for the oxidation of hydrogen sulfide. This mechanism is consistent with the mineralogy which confirmed the formation of secondary sulfur which is not associated with chalcopyrite but is associated with fine pyrite if present.

A comparison of this mechanism with that proposed in other more limited studies of the dissolution of chalcopyrite under similar conditions in sulfate solutions has been made.

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Dedicated to my parent Juan and Margarita.

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