

**WEDNESDAY, AUGUST 24, 2005, P.M.**

**SESSION 41: INTERNATIONAL SYMPOSIUM ON COMPUTATIONAL ANALYSIS IN HYDROMETALLURGY (35<sup>TH</sup> ANNUAL HYDROMETALLURGY MEETING)**

**CHEMICAL AND PHYSICAL MODELLING II**

Sponsor(s): Hydrometallurgy Section, The Metallurgical Society of CIM

Room: Herald

Chairmen: P. SCHWARZ, CSIRO Minerals, Australia and  
M. DRY, University of Toronto, Canada

PAPER 41.1—14:00

**MODELLING A SEMI-BATCH REACTIVE PRECIPITATION OF FERRIHYDRITE.**

T.S. LI, D. ILIEVSKI, CSIRO Minerals, Australia and

W.R. RICHMOND, Curtin University of Technology, Australia

The reactive precipitation of ferrihydrite was studied in a laboratory semi-batch precipitator, where a highly concentrated sodium hydroxide solution was fed into an iron nitrate solution. Instantaneous hydrolysis of iron[III] takes place when the two reagents are mixed generating supersaturation, and leading to immediate precipitation of ferrihydrite via a primary nucleation mechanism then followed by limited crystallite growth to 3 to 7nm. A mathematical model of the semi-batch laboratory precipitator was used to simulate the pH responses during the precipitation of ferrihydrite at different reagent feed rates. The model comprised of interconnected compartments of averaged hydrodynamic conditions, incorporating physically meaningful turbulent mixing time constants. The precipitation process is described by the solute concentration conservation equation incorporating a postulated ferrihydrite primary nucleation model. It was found that the semi-batch precipitator model predicted the experimental pH response reasonably well. The experimental results demonstrated that the reagent feed rate has a critical effect on the course of the precipitation of ferrihydrite, i.e. it is a rate determining step given the fast hydrolysis and precipitation kinetics.

PAPER 41.2—14:25

**POINT OF ZERO CHARGE (PZC) AND DOUBLE LAYER ADSORPTION – AN EQUILIBRIUM CALCULATION APPROACH.**

H.-H. HUANG, L.G. TWIDWELL and C.A. YOUNG, Montana Tech, U.S.A.

Solid particles, especially oxides/hydroxides, develop an electrical charge on their surface when submerged in aqueous solution. Parks was able to relate PZC (point of zero charge) of an oxide to its minimum solubility and isoelectric point. Dzombak has compiled an extensive database for adsorption reactions on ferrihydrite surfaces using the double layer theory. The equilibrium calculational program, STABCAL has been used to extend the considerations of Parks and Stumm. The PZC for many hydroxides, complex oxides, and non-oxides have been investigated and the results are reported in the literature. Removal of arsenic and metals by adsorption on ferrihydrite as the substrate has been computed using STABCAL and the computational results are compared to experimental data. Absorbents other than ferrihydrite such as aluminum hydroxide are also discussed.

PAPER 41.3—14:50

**MICROMIXING IN THE GIBBSITE CAUSTIC ALUMINATE PRECIPITATION SYSTEM.**

T.S. LI, D. ILIEVSKI and I. LIVK, CSIRO Minerals, Australia

Micromixing of the fluid and the particulate phases in a continuous gibbsite precipitator was investigated for three different micromixing states, namely maximum mixedness (MM), complete segregation (CS), and maximum mixedness of the fluid but complete segregation of the particulates (MMF-CSP). The influence of the micromixing on continuous precipitation of gibbsite was studied at different precipitation conditions via simulation. Three different cases were considered with respect to the precipitation kinetics: (1) gibbsite secondary nucleation is favoured with slow crystal growth and agglomeration rates; (2) gibbsite crystal agglomeration and growth are dominant mechanisms with secondary nucleation suppressed; and (3) gibbsite crystal growth is the only relevant phenomenon. Simulation results for the cases (1) and (3) showed that the crystalline products for both the MM and MMF-CSP micromixing states were very similar, but the product obtained from the CS micromixing state was considerably different. This indicates that at those precipitation conditions the fluid micromixing has the dominant effect on the product properties, and the particulates micromixing effect is insignificant. However, when operated under the conditions of fast crystal growth and agglomeration kinetics, i.e. case (2), both the fluid and the particulates micromixing were found to affect the precipitation process, resulting in a significantly different product.

COFFEE BREAK—15:15-15:45

PAPER 41.4—15:45

MATHEMATICAL MODEL OF THE AGUILARITE ( $\text{Ag}_4\text{SeS}$ ) LEACHING PROCESS IN THE PRESENCE OF OTHER REFRACTORY SILVER PHASES.

R.M. LUNA-SÁNCHEZ and G.T. LAPIDUS, Universidad Autónoma Metropolitana, Mexico

In the present study, a series of cyanidation experiments were performed on a bulk sulfide concentrate which contained silver in four distinct phases, to determine its extraction rate, varying the oxygen concentration. The results showed that three of the four phases were refractory, aguilareite ( $\text{Ag}_4\text{SeS}$ ) being the only leachable phase, and that the effect of the oxidant concentration is minimal. Mathematical simulations were performed, adjusting only the Damköhler number to adequately fit the experimental data. This model, and the mechanism implied, was compared with that found for acanthite ( $\text{Ag}_2\text{S}$ ) in a previous study, and the differences between the two discussed.

PAPER 41.5—16:10

MATHEMATICAL MODEL FOR THE LEACHING OF ACANTHITE ( $\text{Ag}_2\text{S}$ ) IN THIOSULFATE SOLUTIONS.

J. TREJO-GALLARDO and G.T. LAPIDUS, Universidad Autónoma Metropolitana, Mexico

A phenomenological model is presented for leaching silver from silver sulfide contained in mineral particles with ammoniacal thiosulfate solutions of copper in stirred reactors. Experimental results were used to adjust the kinetic parameters of the model, such as the reaction order and velocity. The incorporation of the cuprous sulfide-silver sulfide equilibrium at the reaction interface allowed the prediction of the conversion limits for different reagent concentrations. The information obtained from the reactor model was later integrated into a heap leaching simulation, whose results adequately describe tendencies observed in column tests, with respect to variations in copper and thiosulfate concentrations.

PAPER 41.6—16:35

MATHEMATICAL MODELLING OF OXIDATIVE LEACHING OF NICKEL CONCENTRATE MAGNETIC FRACTION.

E.E. ZHMARIN, E.M. VIGDORCHIK, M.I. KALASHNIKOVA, Y.M. SHNEERSON, Gipronickel Institute, Russia, and

Y.V. DEGTIAREV, Severonickel Plant, Russia

Separation of a magnetic fraction from nickel concentrate following matte flotation, and its treatment in a separate circuit enable reduces precious metals losses. The magnetic fraction is treated in two stages of oxidative leaching: atmospheric and pressure leaching. A study of the atmospheric stage, using mathematical modelling, is described in this paper. The mathematical model and experimental data were used to carry out industrial process calculations. The model enabled extrapolation of the results of batch laboratory test to industrial-scale continuous processing and the selection of optimal process conditions and large-scale equipment. In December 2004, commercial oxidative leaching tests were performed on the magnetic fraction at the Severonickel Plant (Monchegorsk, Russia). A comparative analysis of the mathematical modelling results and the actual process parameters is presented.