MONDAY, AUGUST 22, 2005, P.M.

SESSION 1: INTERNATIONAL SYMPOSIUM ON COMPUTATIONAL ANALYSIS IN HYDROMETALLURGY (35TH ANNUAL HYDROMETALLURGY MEETING)

COMPUTATIONAL FLUID DYNAMICS AND DATA ANALYSIS
Sponsor(s): Hydrometallurgy Section, The Metallurgical Society of CIM
Room: Herald
Chairmen: M. DRY, University of Toronto, Canada and
D. DIXON, University of British Columbia, Canada

PAPER 1.1—14:00
HYDRODYNAMIC MODELLING OF HYDROMETALLURGICAL UNIT OPERATIONS.
M.P. SCHWARZ, CSIRO Minerals, Australia

CSIRO Minerals, in association with the AJ Parker CRC for Hydrometallurgy, has an active program of hydrometallurgical research in which physical and computational modelling are used to better understand and improve a range of different unit operations. The modelling is based on flow simulation (Computational Fluid Dynamics or CFD), but incorporates other physical and chemical phenomena of importance, such as droplet break-up and coalescence, species transport and reaction. This paper reviews some of the major projects that have been undertaken at CSIRO Minerals and will illustrate the critical importance of hydrodynamics to the performance of unit operations and the improvements that can be made to performance using such modelling techniques. Unit operations that are discussed include solvent-extraction, gravity thickeners, flotation cells, bio-heap leaching and stirred tanks.

PAPER 1.2—14:25
APPLICATION OF CFD MULTIPHASE MODELLING TO HYDROMETALLURGICAL PLANTS.
L.M. OSHINOWO, Hatch Associates Ltd, Canada

The incorporation of advanced analysis tools, such as CFD, into the process plant design process has become possible through advances in commercially available computational fluid dynamics software and faster computers. Multiphase modeling is now typically employed in the design phase of process plant design at Hatch. The multiphase models include Lagrange-Euler and Euler-Euler treatment of the multiple phases. Additionally, mixture models with interface-sharpening algorithms are applied to the prediction of free-surface flows in complex geometry. CFD is applied to applications where traditional design rules are not applicable. The additional rigor of CFD modeling in 2D and 3D allows process engineers to come closer to realizing true virtual plant design. The objective of this paper is to outline the benefits and pitfalls in the application of multiphase modeling for rigorous design. Several application examples in the hydrometallurgical field will be presented.

PAPER 1.3—14:50
PRELIMINARY RESULTS OF A HYDRODYNAMIC STUDY ON A PLASMA-LIFT REACTOR.
L. MUNHOLAND, P. QUINTAL and G. SOUCY, Université de Sherbrooke, Canada

This work presents early results from the first study to optimize the hydrodynamics of a Plasma Lift Reactor (PLR). The PLR is designed to break down organic contaminants in aqueous solutions. New experimental results are presented for air/water tests and for plasma degradation of organic contaminants in Bayer liquor. In addition, a multiphase Computational Fluid Dynamics (CFD) model has been developed which predicts the hydrodynamic behavior in the PLR. These results of this work suggest the PLR is effective at reducing contaminants in the Bayer liquor and that the CFD model adequately describes the hydrodynamic flow.

COFFEE BREAK—15:15-15:45

PAPER 1.4—15:45
MODELLING VARIABLY SATURATED FLOW IN POROUS MEDIA FOR HEAP LEACH ANALYSIS.
D. MCBRIDE, M. CROSS, N. CROFT, C.R. BENNETT, University of Greenwich, United Kingdom and
J. GEBHARDT, Process Engineering Resources Inc., U.S.A.

A comprehensive model of solution flow through heap leach systems requires a numerical solution with the ability to predict variably saturated-unsaturated flow through porous media domains that contain materials with spatially variable properties. The types of flow associated with stockpile leach processes lead to flow problems, such as infiltration into dry soil, drainage, perched water tables and flow through heterogeneous materials. Computational methods for modelling this class of flow behaviour are conventionally based on the classical Richards' equation.

However, the governing equations are highly non-linear, difficult to solve, and require iterative numerical solution methods. The pressure-based form of the Richards' equation suffers from poor mass balance, while the mixed form can possess convergence difficulties. An adaptive transformed mixed algorithm is described, which reduces the non-linearity of the problem, optimizes the time step size, and provides a fast, numerically robust scheme that significantly reduces computation (or CPU) time. This method is shown to give fast, accurate solutions on a number of complex flow problems. The utility of this algorithm is illustrated through its implementation within the PHYSICA computational modelling software, which incidentally, provides a framework for a comprehensive heap leach model.

PAPER 1.5—16:10

FAULT DIAGNOSIS IN METALLURGICAL PROCESS SYSTEMS WITH SUPPORT VECTOR MACHINES.

G.T. JEMWA and C. ALDRICH, University of Stellenbosch, South Africa

Fault detection and identification are major challenges in process engineering and manufacturing and the key component of abnormal event management systems. Timely detection, diagnosis and rectification of abnormal or faulty process conditions can lead to savings of billions of dollars in equipment damage and lost productivity, not to mention the prevention of injury and loss of human life associated with industrial accidents. A major contributing factor to current losses in industry is the reliance on human operators to interpret high-frequency samples from hundreds or thousands of variables simultaneously. As a result, the automation of fault detection and diagnosis is seen as crucial to the successful implementation of abnormal event management, the need for which is becoming all the more urgent given the increased complexity associated with modern industrial plants. In this paper, a methodology for process monitoring that uses support vector methods to extract nonlinear features from data is discussed and applied in the diagnostic monitoring of an industrial liquid-liquid extraction column.

PAPER 1.6—16:35

ANALYSIS OF ELECTROCHEMICAL NOISE DATA WITH PHASE SPACE METHODS.

C. ALDRICH, B.C. QI and A.J. MAKOKA, University of Stellenbosch, South Africa

Reliable monitoring of corrosion is vitally important in the combat against corrosion and over the last two decades the interpretation of electrochemical noise has received considerable attention as a means to discriminate between different types of corrosion. To this end, many different analytical methods have been proposed, such as power spectral density analysis and analysis via various other stochastic criteria. However, although many corrosion systems are nonlinear and therefore not readily interpretable by the abovementioned analytical approaches, few studies in the analysis of electrochemical noise to date have exploited advances made in the analysis of nonlinear systems. In this paper, the use of phase space methods to analyze and detect change in corrosion systems via electrochemical noise is considered. In particular, the electrochemical noise data are used to reconstruct trajectories in the so-called phase space of the system and changes in the topology of these trajectories or attractors as represented by correlation dimension curves are consequently interpreted as an indication of change in the dynamics of the system.