

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

**SESSION 47: INTERNATIONAL SYMPOSIUM ON THE TREATMENT OF GOLD ORES**

MODELLING AND ENVIRONMENT

Sponsor(s): Hydrometallurgy Section, The Metallurgical Society of CIM, Canadian Mineral Processors  
Division of CIM, CANMET-MMSL

Room: Imperial Ballroom 3

Chair(s): L. LORENZEN, University of Stellenbosch, South Africa and  
J.A. FOLINSBEE, PJV, Canada

PAPER 47.1 — 14:00

GOLD LIBERATION MODELLING OF DIAGNOSTIC LEACHING DATA USING NEURAL NETWORK ANALYSIS.

L. LORENZEN, N. MUSEE and N. KORNELIUS, University of Stellenbosch, South Africa

This study presents a neural network approach to modelling the liberation of gold bearing ores. A complete mineralogical analysis of unmilled and milled ores, including gold deportment and gangue content are used as inputs to a self-organising neural net which generates order preserving topological maps. The arrangement and shapes of these clusters are coupled to unmilled free gold data to predict gold liberation in milled ores (absolute error: 4.2%). Moreover, the self-organising maps were diagnostic of the quality of data used, indicating that the relationship between particle size and gangue material content requires further investigation.

PAPER 47.2—14:25

SIMULATORS FOR THE DESIGN, OPTIMIZATION AND CONTROL OF GOLD ORE PROCESSING PLANTS.

L.R.P. DE ANDRADE LIMA, McGill University, Canada, and  
D. HODOUIN, Université Laval, Canada

The paper presents a survey of the possibilities of the simulation techniques for improving the design and operation of gold processing plants. The procedure to construct kinetic models that are used in simulators is first reviewed, and examples are given for cyanide gold dissolution and gold adsorption on carbon. Then, an overview of the structures of the plant simulators is proposed, and the simulation equations formulated for a carbon-in-leach process. Finally, the potential of simulation methods is illustrated by four examples. The first one shows how it is possible to use a simulator to design a cascade of leaching tanks while optimizing an economic performance criterion. The second one illustrates the role of simulators for optimal tuning of the cyanide addition strategy in a leaching circuit. The third example focuses on the power of simulation to design carbon transfer strategies in a carbon-in-pulp process. Finally, the last example shows the role of on-line simulators for optimally supervising the automatic control of cyanide addition into leaching tanks.

PAPER 47.3—14:50

DESTRUCTION OF CYANIDE IN TAILING POND RECLAIM WATER USING PEROXYMONOSULFURIC ACID AT BARRICK GOLDSTRIKE.

P. BUTCHER, A.S. IBRADO, M. DROZD and, Barrick Goldstrike, U.S.A.  
L. ENLOE, Barrick Gold, Inc., U.S.A.

While effective in treating refractory sulfide ores, pressure oxidation leaves carbonaceous matter unscathed and able to adsorb gold from cyanide solutions. Barrick Goldstrike's strategy to mitigate this problem is to minimize contact between dissolved gold and native carbon in advance of the carbon-in-leach (CIL) process. Measures currently in use include limiting carbonaceous matter in the plant feed by meticulous blending of ore, minimizing chloride in the process streams, controlling the degree of oxidation in the autoclaves and blinding native carbon surfaces with lauryl sulfate. Residual cyanide in the process water remains to be a cause of premature gold dissolution and loss of gold by adsorption on carbonaceous matter. This cyanide is introduced by water that is recycled from the tailing pond. Several treatment options were considered and oxidation by peroxymonosulfuric acid, also known as Caro's acid, was deemed to be the most effective. Laboratory and pilot plant tests show that Caro's acid can oxidize free cyanide, weak-acid-dissociable (WAD) cyanide and thiocyanate, resulting in significant improvements in gold recovery downstream. The process requires Caro's acid at 125 % of stoichiometric and pH in the range of 9.5 to 10 to accomplish the desired destruction in about twenty minutes. A cyanide destruction plant is currently being designed and slated for completion early in 2005.

COFFEE BREAK—15:15 – 15:35

PAPER 47.4—15:35

CYANIDE RECOVERY BY SOLVENT EXTRACTION IN A CONTINUOUS PILOT PLANT.

K. LARMOUR-SHIP, E. BUCHALTER Bateman Engineering, Canada,  
D. DREISINGER, B. WASSINK, University of British Columbia, Canada,  
R. HACKL, M. HAMES, Placer Dome Technical Services Limited, Canada,  
B. GRINBAUM, IMI TAMI Institute for Research & Development, Israel

Sodium cyanide continues to be the lixiviant of choice for gold dissolution world-wide. Many gold ore-bodies contain a significant amount of cyanide-soluble copper which increases the cost of processing due to high cyanide consumption and high cyanide destruction and disposal costs. Several cyanide destruction processes are in use today, however, there are few cyanide recovery circuits operating. A solvent extraction process utilizing the organophosphorous extractant Cyanex 923 in Bateman Pulsed Columns. Copper cyanide species are first converted to dissolved HCN by acidification, with or without sulphide addition. HCN is then extracted and the organic stripped using a base (eg. NaOH) resulting in a high strength cyanide solution (eg. NaCN) for recycle to the milling circuit. Continuous mini-pilot testwork on HCN extraction using a 40 mm Bateman Pulsed Column demonstrated a cyanide recovery of greater than 99% with final levels of cyanide in solution of less than 10 ppm. These results illustrate the potential of this technology to recycle cyanide and detoxify final effluent streams.

PAPER 47.5—16:00

USE OF A ROTATING BIOLOGICAL CONTACTOR FOR THE REMOVAL OF NITROGENOUS COMPOUNDS FROM GOLD MILL EFFLUENT.

D. GOULD, S. MORTAZAVI, A. KAPOOR, P. BEDARD and L. MORIN, Natural Resources Canada, Canada

The degradation of thiocyanate in a simulated gold mill effluent was studied using a laboratory scale rotating biological contactor (RBC). Complete  $\text{SCN}^-$  removal was obtained at temperatures of 8 and 12°C, and a hydraulic retention time of approximately 3.3 h. The  $\text{NH}_4^+$  produced by thiocyanate hydrolysis was oxidized by nitrifying bacteria to  $\text{NO}_2^-$  and  $\text{NO}_3^-$ . The  $\text{HS}^-$  produced by thiocyanate hydrolysis was chemically and biologically oxidized to elemental S, which was subsequently biologically oxidized to sulfate. Incomplete sulfur oxidation occurred in the RBC, particularly at 8°C and elemental sulfur deposition was observed on the RBC disks. The RBC feed exhibited toxicity to rainbow trout but the RBC was effective in removing the acute toxicity of thiocyanate.

PAPER 47.6—16:25

CYANIDE REMOVAL FROM GOLD PROCESSING FACTORY'S WASTE WATER USING CALCIUM AND SODIUM HYPOCHLORITE.

A. KHODADADI, P. TAIMORY and M. ABDOLADI, T. Modares University, Iran

Cyanide is used by the mining and chemical industries in tremendous quantities without attention to its hazardous problems. The use of cyanide compounds in mining is one of the most important environmental issues due to the acutely toxic properties of many cyanide compounds to human. Cyanide tends to react readily with most other chemical elements, producing a wide variety of toxic, cyanide-related compounds. Because cyanide is carbon based, an organic compound, it reacts readily with other carbon-based matter, including living organisms. This research is aimed at investigating a feasible and economical technique for removal of cyanide from tailing wastewater of Muteh Gold Mine. In this research, removal from Muteh factory's waste water was achieved at Tarbiat Modares University's Mineral Processing Laboratory with the oxidation of cyanide by calcium hypochlorite. Cyanide oxidizes to cyanate ( $\text{CNO}^-$ ), which is environmentally 1000 times less toxic than cyanide. Cyanide titration was performed with silver nitrate and rhodanine as indicator. Cyanide concentration in wastewater was 270 mg/L. Cyanide removal was achieved at an optimum pH of 12.3. At higher temperatures, cyanide was completely removed at this pH level. Optimum dosage for complete removal of cyanide using calcium hypochlorite was 1.43g/L.