# TUESDAY, AUGUST 23, 2005, P.M.

## SESSION 28: INTERNATIONAL CONFERENCE ON NICKEL AND COBALT

### PROCESS FUNDAMENTALS I

Sponsor(s): The Non-Ferrous Pyrometallurgy Section, Metallurgical Society of CIM
Room: Doll
Chair(s): C. Pickles, Queen's University, Canada, and
S. MARCUSON, Inco Technical Services Ltd., Canada

PAPER 28.1—14:00

MODELING OF NICKEL LATERITE KILN PROCESSING: A CONCEPTUAL REVIEW.

S. KASHANI-NEJAD, I. CANDY and M. KOZLOWSKI, Hatch, Canada

The production of ferronickel and matte from nickel laterite ores is dominated by the Rotary Kiln, Electric Furnace (RKEF) process. Over time, major improvements have been made to kiln operation. In particular, kilns are now required to perform substantial amounts of reduction of the metallic oxides, thereby reducing the load on the electric furnace and substituting less expensive fossil fuel for electrical energy. To the basic refractory lined cylinder have been added; internal features such as dams and lifters, aimed at changing residence times in different sections of the kiln and enhancing gas/solids interaction, on-board blowers to introduce tertiary air and on-board scoop mechanisms to allow reductant coal additions to be made at advantageous locations along the kiln. Many of these advances in design have been made on a trial and error basis and by borrowing technology from related kiln processes supplemented by proprietary modeling to various levels of sophistication. This paper presents a conceptual review of modeling components for the development of a computational model for granular material flow, combustion and heat and mass transfer in a nickel laterite kiln. These components include: granular material flow and the segregation models for the simulation of bed motion in the kiln cross section as well as axial progress of the bed material; heat transfer models that simulate heat transfer by turbulent diffusion and radiation to the boundary surface of bed material and the distribution of this thermal energy within the bed; fluid flow models for the prediction of combustion aerodynamics.

PAPER 28.2—14:25

RECOVERY OF NICKEL FROM TAILINGS POND SLUDGE BY LEACHING AND OZONATION.

L. CALZADO, R. RAO, F. BARRIGA and J. FINCH, McGill University, Canada

Sludge in the tailing ponds of Sudbury region contains 5-7 % Ni mostly as hydroxide and is associated with Fe (~ 10 %), Mg (~ 10 %) and Cu (~0.5 %) as hydroxides and Ca (~3.5 %) as sulphate. Investigations were conducted to recover nickel by a 2-stage process. In the first stage, the sludge was leached with sulphuric acid at pH 3.2. The solution separated from the ferric hydroxide mainly contained nickel and magnesium. In the second stage, nickel was separated by treating with ozone, which oxidizes nickel present as Ni2+ to Ni3+. By this oxidation all soluble nickel was precipitated as nickel oxide-hydroxide of stoichiometric formula, NiOOH with 58 % Ni. Up to 90 % of nickel is recovered. The oxide readily settles down and can be easily separated. It is suggested as a potential feed stock to recover nickel metal by direct reduction or to manufacture nickel compounds. The leach residue contained 0.5 % Ni and 11 % Fe. It passed the standard leachability test and can be disposed off or used as feed stock to produce ferric sulphate, which is a useful industrial coagulant. The physical properties of nickel oxyhydroxide and process parameters including ozone consumption will be discussed.

PAPER 28.3—14:50

X-RAY VISUALIZATION OF GRAPHITE REDUCTION OF MOLTEN NICKEL MATTE/OXYSULFIDE/SLAG.

J. LIU, Inco Technical Services Ltd., Canada and
T. UTIGARD, University of Toronto, Canada

In order to improve value metals recovery, a new operating concept for the Inco flash furnace was investigated, in which flash furnace coke addition would aim at establishing a reducing barrier on the surface of the molten bath. In this scenario, the descending partially oxidized sulfide particles would reach the supernatant coke layer prior to the formation of slag. The key for the success of the new operating concept depends on the effectiveness (kinetics) and efficiency of the coke layer to produce a sulfur deficient matte without requiring furnace geometry modifications, and while maintaining furnace production capacity. The mechanism and rate of carbon reduction of each of the phases that are formed in the flash flame, i.e. sulfide (matte) and oxysulfide was investigated by means of X-ray visualization test work. Graphite-slag reduction was also conducted for comparison purposes. In the case of slag, poor wettability and the formation of a gas film on the surface of the carbon reductant, are often blamed for limiting the reaction surface area that ultimately results in poor reaction kinetics. Unlike slag reduction, very little research work has been conducted on the reduction of matte and oxysulfide. The high temperature X-ray visualization test work confirmed

that: (1) matte and oxysulfide wet coke better than slag; (2) the slag-graphite reduction product gas is discharged through a gas film that envelopes the graphite; and (3) the rate of reduction of matte and oxysulfide is semi-quantitatively faster than that of slag.

COFFEE BREAK—15:15-15:30

PAPER 28.4—15:30

RECOVERY OF NICKEL FROM METALLURGICAL SLAGS.

E. ZEVGOLIS, S. C. LIVANOU, National Technical University of Athens, Greece and
S. P. TAMPOURISSA Larco, Greece

In ferronickel (Fe-Ni) production from oxidized nickeliferous ores, mechanical losses of ferronickel in the slag are reduced by magnetic separation. Slag from the electric furnaces (E/Fs) contains 0.16% Ni. Its magnetic separation gave a pre-concentrate with 0.76% Ni, weighing approximately 6.5% of the feed. Nickel recovery was 29.7%. This pre-concentrate was then treated in a second (concentration) plant. Concentration treatment involves screening, crushing and magnetic separation. A pre-concentrate with 0.76% Ni gave a magnetic concentrate with 2.58% Ni and a non-magnetic part with 0.35% Ni. Smelting of the non-magnetic part without the addition of a reduction agent in a laboratory electric arc furnace, gave a ferronickel alloy with approximately 20% Ni and a slag with 0.16% Ni.

PAPER 28.5—15:55

MICROWAVE SMELTING OF NICKELIFEROUS SILICATE ORES.

C. PICKLES, Queen’s University, Canada

Microwaves are being applied industrially in a number of fields and provide many benefits that could be applied in extractive metallurgy. Microwave heating is different from the conventional heating methods which involve mainly conduction and convection. In microwave processing, the heat is generated within the material itself and the absorption of the microwaves occurs at the molecular or atomic level. The heating rate is fast, and the interior temperature of the sample is higher than the surface, in contrast, to conventional heating. In this research, the application of microwaves to the smelting of a nickeliferous silicate laterite has been studied. The effects of the important operating variables on the ferronickel grade and the nickel recovery are discussed.

PAPER 28.6—16:20

EXTRACTION OF NICKEL FROM PAL SOLUTIONS USING ELECTROSTATIC PSEUDO LIQUID MEMBRANES.

D. IBANA and M. STEFFENS, Western Australia School of Mines

The extraction of nickel from acidic leach solutions using electrostatic pseudo liquid membrane (ESPLIM), a novel separation technique that combines the advantages of solvent extraction and electrostatic dispersion, was investigated. At optimum conditions, device as a result of this investigation, complete extraction of the nickel was achieved in only two extraction stages compared with four by the conventional solvent extraction technique. In addition, three months of simulated extraction and stripping showed that an applied voltage up to 5 kV had no adverse effect on the stability of the organic reagents. These results indicate the commercial viability of the technique.