

POSTER SESSION

Room: Chedoke A

Chairman: M. BARATI, McMaster University, Hamilton, Ontario, Canada

POSTER 1

EFFECT OF SOLID PARTICLE IMPINGEMENT ON THE PASSIVE BEHAVIOR OF CARBON STEEL.

H.X GUO, J.L LUO and B.T LU, University of Alberta, Edmonton, Alberta, Canada

The effect of solid particle impingement on the passive behavior of A1045 carbon steel in boric solution was investigated by electrochemical methods. Experimental results show that the presence of sands lowers the final steady open circuit potential dramatically. Both polarization curves and potentiostatic measurements indicate that the passive current density of the steel increases with the concentration of the sands. However, the breakdown potentials of the material depend not only on the solid particle impingement but also on the chemistry of slurry.

POSTER 2

A COLLABORATIVE WEAR COSTS REDUCTION INITIATIVE FOR THE CANADIAN MINING INDUSTRY.

D. KUMAR and R. LLEWELLYN, NRC Institute for Fuel Cell Innovation, Vancouver, British Columbia, Canada

Wear causes enormous losses in mining and mineral processing. It has a very profound effect on the profitability, productivity and global competitiveness of Canadian mining companies. A collaborative NRC/Industry program on wear materials research was initiated in 1996 to address the needs of the industrial sector. Its mandate involved (i) establishing the abrasion and erosion properties of all classes of wear materials (ii) helping to develop improved wear protection systems (iii) addressing chronic wear problems and (iv) compiling/maintaining a wear properties database to facilitate effective materials selection.

Since its inception with Syncrude as the sole industrial sponsor, the program has grown to a membership of ten major companies. They include oil sands operations in N. Alberta, hard rock miners with interests across the breadth of the Country and some selected suppliers of critical wear resistant materials and components. It is supported by a worldwide group of cooperating manufacturers of wear products.

Targets are being achieved using extensive capabilities that are available for determining wear behaviour under simulated service conditions. These are complemented by techniques for characterizing wear damage and relating performance to microstructure.

POSTER 3

RECOVERY OF VALUABLE MATERIALS FROM OLD COPPER FLOTATION TAILINGS IN LEFKE (CYPRUS).

H. DINÇER, G. ÖNAL, Istanbul Technical University, Maslak, İstanbul, Turkey

E. GOCK and R. LIPS, Clausthal Technical University, Clausthal, Germany

In this research, it was aimed to recover valuable materials from old copper mine tailings in Lefke-Cyprus and to fill up the residues to old open pit cavities. Approximately, 9.5 Million tons of tailings from old copper mine have been disposed to the tailing pond in Lefke-Cyprus. By applying proposed flow sheet in this research, approximately, 24,000 tonnes of Cu, 500 tonnes of Co and 20 tonnes of gold will be produced as valuable materials. Economical evaluation shows that, 220 million USD can be gained totally.

In view of the environmental aspect, it would be possible the reclamation of the old mining area by using annual income with removing of the 9.5 million tonnes of tailings from the area next to the Mediterranean Sea. Tailings contain mainly, iron, silicium, aluminium, calcium and sulfur oxides besides some heavy metals. Therefore, these tailings are the reason of important environmental problems for 50 years. Tailings also contain 0.6% copper, 0.016% cobalt and 5 g/ton gold. According to the particle size analyses 85% of the tailings were found in minus 20 micron. During the studies, pressure leaching tests were conducted for the recover of iron, copper and cobalt. Water and sulphuric acid was used for the leaching solution. The effect of leaching time, sulphuric acid concentration, temperature and pH have been investigated during the leaching tests. As a result of the leaching tests, it is possible to obtain cobalt and copper with recovery of 100% and 89% from tailings. Therefore according to the test results, it is proposed a flowsheet to recover the valuable metals and after that to produce gold by the cyanidation from the residues having 68% of tailings.

POSTER 4

EFFECT OF CORROSIVITY OF WASTEWATER SLURRY ON SYNERGISM OF EROSION-CORROSION.

C.W. CHEN, B.T. LU, J.L. LUO and T. YU, University of Alberta, Edmonton, Alberta, Canada

The complexity of erosion-corrosion problem arises mainly from the synergistic effect caused by the interaction of mechanical and chemical factors in the service conditions. Depending on the mechanisms of material damage, the

synergism can be divided into erosion-enhanced corrosion and corrosion-enhanced erosion. In this work, the corrosivity of wastewater slurry, including chemistry of solution and sand concentration, on the corrosion-enhanced erosion of carbon steel was experimentally investigated. The experiments were conducted under galvanostatic conditions and the kinetics of material loss was assessed. The experimental results indicated that the anodic dissolution rate on the test surface was an important factor controlling the kinetics of corrosion-enhanced erosion. The mechanism behind was discussed in light of the chemo-mechanical model developed recently by the authors.

POSTER 5

EVALUATION OF LIGNITE COAL IN WASTE CHARACTER AS COAL-WATER SLURRY FUEL.

F. BOYLU and G. ATESOK, Istanbul Technical University, Maslak, Istanbul, Turkey

This study covers the studies of CWS preparation and combustion properties on the Turkish lignite with low calorific (3675 Kcal/kg) value and high ash forming minerals (41%) that may be regarded as coal wastes. The particle size, coal concentration, air/fuel ratio and atomizing air pressure effects on both slurry preparation and combustion processes were investigated. On preparation of CWS studies the low coal concentration in slurries was reached for a required viscosity and stability values. The slurries with solids concentration of 50% (by weight) and maximum stability of 7 days were obtained with this kind of coal. But the high combustion efficiencies were reached although the coal property affects the CWS preparation process. Combustion efficiencies ranged from 96.5% to 99% were obtained with heat loss of 2 % of total heat produced, although it consists of 60% water (by weight). With this study it was emphasized that the CWS prepared by low rank coals could be used as fuel without any upgrading processes.

POSTER 6

RAPID HEAT TREATMENT OF METALS BY ULTRA-SHORT LASER PULSES.

F. LEFEVRE-SCHLICK and D. EMBURY, McMaster University, Hamilton, Ontario, Canada

Ultra-short laser pulses (nano/pico/femtosecond) allow the deposition of controlled intensities (from 10^7 up to 10^{14} W/cm²) in a small volume (a few μm^3) near the surface of materials. Such irradiations induce a rapid change in temperature with heating/cooling rates up to 10^{12} K/s and/or a rapid change in pressure (up to several TPa). Ultra-short laser pulses can then be used as a tool to investigate the first stage of nucleation processes in recrystallization and phase transitions in metals. More specifically, the effect of local misorientations, carbides size and distribution, and strain gradients, on nucleation processes is investigated via the use of ultra-short laser pulses.

POSTER 7

DROSS FORMATION IN CONTINUOUS HOT-DIP GALVANIZING PROCESSES.

J. NAKANO, G.R. PURDY and D.V. MALAKHOV, McMaster University, Hamilton, Ontario, Canada

Steels used in oxidizing environment are typically metal-coated to protect the surface. One of the techniques extensively used in the steel industry for creating a protective coating is hot-dip galvanizing. Unfortunately, this process is accompanied by the formation of various intermetallic particles (dross) in the interior of a galvanizing bath. Dross formation is a serious economical, technological and environmental problem. In this contribution, the mechanism of dross formation is analyzed.

The analysis is based on the assumption that solubility of Fe in the bath is governed by the metastable equilibrium between the BCC and liquid phases. This supposition is consistent with the experimental fact that the Fe concentration in the melt near the steel surface is much higher than that dictated by the equilibrium phase diagram. Calculations of supersaturation achievable in the Zn-Fe-Al system (Figure 1) are based on the thermodynamic properties of three binary systems¹⁻³. For predicting the nature of phases forming from the supersaturated melt and a sequence of their formation, the concept of the driving forces for the onset of precipitation can be employed. Although this combined "metastable solubility + driving forces" approach was initially utilized for describing processes occurring when pure Fe is immersed in pure molten Zn, it can be generalized to the case when a galvanizing bath contains Al, Si, Ni and Cr, assuming that the thermodynamic properties of all phases are known. The effect of these elements on metastable solubility is also demonstrated.

The theoretical analyses have shown that the existence of intermediate phases on the surface could impede the iron dissolution. Consequently, a promising pre-coating method intended to reduce the amount of dross has been suggested.

POSTER 8

FLUORINE-FREE MOLD FLUXES FOR CONTINUOUS CASTING OF ULTRA LOW CARBON STEEL SLABS.

J.-W. CHO and H.-G. RYU

Fluorine is essential but detrimental element in mold fluxes for continuous casting of steel. Fluorine is one of the major components of principal crystalline, Cupridine. It also decreases friction between steel shell and copper mold by lowering viscosity. However, dissolved fluorine into cooling water may erode continuous casting facilities. Also, fluorine should be reduced under 15 ppm before drainage. A new mold flux system without fluorine was tested for casting ultra low carbon steel. It is concluded that fluorine-free mold fluxes can yield both the better operational convenience and product quality only if they have appropriate viscosity and crystallization behaviors.

POSTER 9

ORION: A SOFTWARE PACKAGE DESIGNED TO SIMULATE THE LIFE CYCLE PREDICTIONS OF THERMAL BARRIER COATINGS OF A GAS-TURBINE JET ENGINE.

A. PATNAIK, M. ZAMAN and A. SRIVASTAVA, Cistel Information Systems, Ottawa, Ontario, Canada

Highlights:

- multi-component diffusion process
- include stress field
- predict the growth of the oxide layer
- simulate a number of 'what if' scenarios
- flexible input parameters gives a larger range of choice
- crack growth and its influence on the life cycle (to be added in a future release).

The software package is based on MATLAB and uses a user-friendly graphics input. Output can be displayed in various ways. Beta version will be ready by August 2004, and a first version to be released in December 2004.

POSTER 10

MODELLING AND OPTIMIZATION OF AN ELECTRIC ARC FURNACE.

R.D.M. MACROSTY and C.L.E. SWARTZ, McMaster University, Hamilton, Ontario, Canada

The energy-intensive nature of Electric Arc Furnaces (EAFs) makes these operations attractive candidates for optimization. This in turn requires a dynamic model of appropriate complexity, representative of the process under consideration. The model should be sufficiently detailed so as to describe the melting process, chemical reactions and account for reagent and energy additions. This poster describes an EAF model that has been developed, as well as its use in preliminary dynamic optimization studies. The lack of knowledge of reaction mechanisms due to the complex nature of the reacting system is overcome by treating the process as an equilibrium system with mass transport limitations. An important objective of developing this model is to ensure that it can be used within an optimization framework. Therefore of particular importance are the continuity of model equations and the robustness of the model over a wide range of conditions. Dynamic optimization methods are implemented to determine the operating conditions that would maximize a specified performance criterion of the dynamic-algebraic system. The poster addresses some of the features and challenges involved in the modeling and also illustrates the use of mathematical optimization in the enhancement of process performance.

POSTER 11

AQUEOUS CRYSTALLIZATION OF GYPSUM AND HCl REGENERATION BY REACTION OF CaCl_2 AND H_2SO_4 .

A. AL-OTHMAN and G. DEMOPOULOS, McGill University, Montréal, Québec, Canada

One critical issue in chloride hydrometallurgy is the regeneration of the lixiviant HCl that is done commercially by Pyrohydrolysis. In this research, a low temperature HCl regeneration process is investigated that does not only regenerate HCl, but also produces saleable gypsum. This process promises to reduce the generations of wastes by the reaction of spent calcium chloride leach liquors with sulfuric acid solution at low temperature. Experiments were performed to determine the optimum conditions of the reaction in terms of temperature, reagent concentrations, rate of addition/mixing and seeding/recycling to produce marketable gypsum and measure the strength of the regenerated HCl.

POSTER 12

NO TITLE AVAILABLE.

N. BRAIDY, McMaster University, Hamilton, Ontario, Canada

Au-Ag and Co-Ni alloyed nanoparticles (NPs) are studied using transmission electron microscopy (TEM), high-resolution TEM, annular dark-field (ADF) and high-angle ADF, energy-dispersive X-ray and electron energy-loss spectroscopy. Au-Ag alloyed NPs were produced by laser irradiation of a suspension of Au and Ag powder while the Co-Ni NPs were extracted from a sample of laser-synthesized single-wall carbon nanotubes (SWNTs) with a magnet. A method for measuring the composition of beam-sensitive alloyed NPs is described. The study of Co-Ni catalysts of SWNTs is the first to measure the Co:Ni ratio as a function of NP size.

POSTER 13

CREEP AND CRACK INITIATION IN SnPb AND Pb-FREE SOLDER ALLOYS.

D. R. SHIRLEY, University of Toronto, Toronto, Ontario, Canada

Thermal fatigue in solder joints is a major factor in determining the reliability of many microelectronic devices. The process begins with the accumulation of cyclic creep strains to some critical level leading to crack initiation and subsequent crack growth. In most cases, the crack initiation process consumes most of the component life, with propagation occurring relatively quickly. The main objective of this research is to measure solder creep rates and total creep to crack initiation as a function of stress level and temperature for both tensile and shear loads. This will be done for traditional tin-lead eutectic solder and for newer lead-free solder of a tin-silver-copper composition. These data will then be used to develop a model to predict the number of thermal cycles required to generate micro-cracks in a solder joint. This will reduce the need to perform expensive and time-consuming accelerated thermal cycling tests on each

new design. The research will also provide a better understanding of the factors governing the relative durability of lead-free and tin-lead solder.

POSTER 14

A NEW METHOD TO STUDY ROLES OF HYDROGEN AND ANODIC DISSOLUTION IN SCC DEVELOPMENT.

B.T. LU and J.L. LUO, University of Alberta, Edmonton, Alberta, Canada

The roles of dissolved hydrogen in X60 pipeline steel and anodic dissolution in the near-neutral pH stress corrosion cracking (SCC) initiation and propagation was investigated under a cyclic loading condition. To control the hydrogen concentration in specimens and the anodic dissolution rate of the specimen independently, a Devanathan cell was used in the SCC experiments. The hydrogen concentrations in specimens were controlled by means of applying a constant potential at the charging side. On the opposite side of specimens, anodic potentials or open circuit potential were applied to control the anodic dissolution rate on the test surface. The experimental observations showed that both dissolved hydrogen in the pipeline steel and anodic dissolution promoted the crack initiation in a wide potential range. The crack growth rate decreased almost monotonically with hydrogen permeation current density but was not affected by the anodic current density.

POSTER 15

EXPERIMENTAL AND NUMERICAL STUDY OF ELASTIC BEHAVIOUR OF MODEL REFRACTORY MATERIALS.

N. TESSIER-DOYEN, J.-C. GLANDUS and M. HUGER, Ecole Nationale Supérieure de Céramique Industrielle, Limoges, France

The thermomechanical properties of bi-phased model materials (vitreous matrix containing spherical alumina inclusions) have been determined by three complementary approaches: experimental, numerical and analytical. If the matrix and inclusions exhibit close coefficients of thermal expansion, the experimental and numerical results lie in the vicinity of the lower bound of the Hashin & Shtrikman's model. If there is dilatometric disagreement between the components, atypical behaviours, similar to those obtained for a family of industrial refractory materials, were observed when the temperature varies.

POSTER 16

HUMIDITY SENSITIVE CHARACTERISTICS OF $\text{Ca}(\text{Ti,Nb})\text{O}_3$.

J.-H. YUK, D.-H. YOU and B.-J. LEE, Yuhan College, Bucheon, Gyunggi-do, South Korea

Humidity sensitive devices of $\text{Ca}(\text{Ti,Nb})\text{O}_3$ were prepared using solid-state oxide synthesis route and their humidity sensitive properties have been investigated. It was found that the impedance of the sensor decreases with increasing relative humidity (RH) and changes about three orders of magnitude in an exponential manner over the whole humidity region. The addition of Nb lowers the resistivity of the sensor and makes the humidity sensitivity higher. The humidity sensitivity of the sensor depends on the sintering temperature and applied frequency. $\text{Ca}(\text{Ti,Nb})\text{O}_3$ humidity sensors show a good long term stability and fast response time with a negligible hysteresis under cyclic humidity changes.

POSTER 17

MULTICOMPONENT DIFFUSION COATINGS AND THEIR APPLICATION ON STEELS.

C. LANTSEVITCH, National Technical University of Ukraine "KPI", Kiev, Ukraine

In NTUU "KPI" the works on creation of new highly effective ways and structures for drawing on a working surface steel and hard alloys of details and tool multicomponent diffusion coatings will be carried out on the basis of transitive metals. The structures of a gas phase formed in the reactionary chamber chemist and thermodynamics of course of reactions carbide of formation on a surface steels and firm alloys are investigated. Are determined a kinetics of growth, structure and properties of coatings received at complex saturation steels Cr, V together with lame. The areas of their application are established.

POSTER 18

POTENTIOMETRIC pH MEASUREMENTS IN CONCENTRATED ELECTROLYTE SYSTEMS AT 250°C USING A YTTRIA-STABILIZED ZIRCONIA SENSOR.

Z. JANKOVIC and V. PAPANGELAKIS, University of Toronto, Toronto, Ontario, Canada

A flow-through system comprising a flow-through yttria-stabilized zirconia electrode and a flow-through external pressure balanced Ag/AgCl reference electrode has been employed for pH measurements in solutions relevant to hydrometallurgical processing of nickel laterite ores. The measurements were performed in the ternary $\text{Al}_2(\text{SO}_4)_3\text{-H}_2\text{SO}_4\text{-H}_2\text{O}$, $\text{MgSO}_4\text{-H}_2\text{SO}_4\text{-H}_2\text{O}$ and $\text{NiSO}_4\text{-H}_2\text{SO}_4\text{-H}_2\text{O}$ systems, as well as the quaternary $\text{MgSO}_4\text{-Al}_2(\text{SO}_4)_3\text{-H}_2\text{SO}_4\text{-H}_2\text{O}$ and $\text{NiSO}_4\text{-Al}_2(\text{SO}_4)_3\text{-H}_2\text{SO}_4\text{-H}_2\text{O}$ solutions. Aluminium sulphate additions had no effect on pH. Increasing magnesium sulphate and nickel sulphate concentrations, however, resulted in an increase in pH. Overall, an acceptable agreement was found between the measured pH values and those predicted using an OLI Systems software package (± 0.17 pH units).

POSTER 19

ACIDITY ESTIMATION OF CONCENTRATED SULPHURIC ACID-METAL SULPHATE SOLUTIONS AT HIGH TEMPERATURES BY CONDUCTIVITY

M. HUANG and V.G. PAPANGELAKIS, University of Toronto, Toronto, Ontario, Canada

A newly developed conductivity cell was employed to investigate the inter-relation between electric conductivity and acidity of sulphuric acid - metal sulphate solutions at high temperatures. The measured solutions include $\text{H}_2\text{SO}_4\text{-H}_2\text{O}$, $\text{H}_2\text{SO}_4\text{-MgSO}_4\text{-H}_2\text{O}$, $\text{H}_2\text{SO}_4\text{-MgSO}_4\text{-Al}_2(\text{SO}_4)_3\text{-H}_2\text{O}$ electrolyte systems. All solutions were measured from 15 to 250°C at the equilibrium vapor pressure. The maximum concentrations of H_2SO_4 , MgSO_4 and $\text{Al}_2(\text{SO}_4)_3$ were 0.45m, 0.3m and 0.1m, respectively.

An empirical model was developed based on the available measurements. This model was tested against laterite leach solutions. The average difference between the estimated $[\text{H}_2\text{SO}_4]$ from this model and the one from titration was less than 5%.

POSTER 20

ENCAPSULATION OF SCORODITE PARTICLES WITH PHOSPHATE MINERAL COATINGS.

F. LAGNO and G.P. DEMOPOULOS, McGill University, Montréal, Québec Canada

The proposed research program aims to develop a method of arsenic fixation suitable for the long-term disposal of arsenic generated by the minerals industry, this research project investigates the encapsulation of scorodite particles, $\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$, with phosphate mineral coatings, materials not prone to reductive decomposition. Reductive decomposition is known to be responsible for the release of arsenic into the environment from arsenate solids such as scorodite. The subject matter of this project is the study and application of heterogeneous crystallisation to produce direct deposition of stable phosphate coatings. Upon precipitation and characterization of coated scorodite particles reductive decomposition will be studied.

POSTER 21

AQUEOUS OXIDATIVE PRECIPITATION OF MANGANESE USING SO_2/O_2 .

V. MENARD and G.P. DEMOPOULOS, McGill University, Montréal, Québec, Canada

In many hydrometallurgical processes, manganese is an impurity that needs to be removed from solution prior to metal recovery. A method of manganese removal is by oxidative precipitation which consists in oxidizing Mn^{2+} to $\text{Mn}^{3+}/\text{Mn}^{4+}$ that precipitates as $\text{Mn}_2\text{O}_3/\text{MnO}_2$. The purpose of the present work is to remove selectively manganese from a zinc-rich solution using an oxidizing gas mixture of SO_2/O_2 . Several semi-batch experiments were performed where the effects of pH, redox potential, SO_2/O_2 ratio, etc. were investigated. These tests were followed by running a multi-reactor continuous circuit employing pH/ORP control and product recycling.

POSTER 22

CRYSTALLIZATION OF ALPHA-CALCIUM SULPHATE HEMIHYDRATE OUT OF CALCIUM CHLORIDE MEDIA.

S. GIRGIN and G. DEMOPOULOS, McGill University, Montréal, Québec, Canada

CaCl_2 can be found in spent industrial chemical solutions or in waste brines from geothermal fields. On the other hand there is surplus H_2SO_4 generated by the non-ferrous metals industry. In this study the production of alpha-calcium sulphate hemihydrate is sought via the controlled reaction of CaCl_2 and H_2SO_4 . Production of alpha-HH is associated with simultaneous regeneration of HCl - a highly sought acid in the hydrometallurgical industry. Through a series of crystallization tests, processing conditions have been determined that allow the production of alpha-HH under atmospheric pressure conditions. In this paper a summary of this research program is presented.

POSTER 23

TREATMENT OF MAGNESIUM SALT SLAG.

R.D. VAN DER WEIJDEN, S. STEENEKEN, I. INZUNZA, P.C. REM, U.M.J. BOIN and M.A. REUTER, Delft University of Technology, The Netherlands

Magnesium salt slag originates from the smelting of unclean magnesium scrap types, which require the use of a salt flux. The slag consists of Mg metal (up to 10%) various magnesium salts (Mg_3N_2 , MgO , MgCl_2) and can contain traces of other impurities (Fe, Ni, Cu, Sr.) The composition of the slag can vary and depends on cooling conditions and scrap type. For recovery of the Mg metal in the slag and treatment of the contaminated salts, that are not disposable according to EU environmental law, several physical (screening and Eddy Current) and chemical (leaching) separation techniques are evaluated. Additionally, a process design for treating the slag is proposed.

POSTER 24

NUMERICAL STUDY OF FROZEN SLAG LAYERS IN NON-FERROUS SMELTING FURNACES.

F. GUEVARA and G.A. IRONS, McMaster University, Hamilton, Ontario, Canada

This study was conducted to understand the chill layer formation and heat transfer that is required to design cooling systems in pyrometallurgical operations where a slag layer is required to protect the furnace wall. Heat transfer and fluid flow for liquids with latent heat and viscosity, (both strongly dependent of temperature near the solidus and

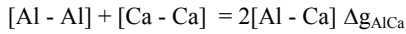
liquidus temperatures), have been studied by numerical simulation. The study has been carried out under natural convection conditions with similar Grashof and Prandtl numbers for copper and nickel slags. The algorithm uses the enthalpy-porosity approach based on a two-dimensional transient finite-volume formulation.

POSTER 25

THERMODYNAMIC INVESTIGATION ON ALKALINE-EARTH IN ALUMINUM ALLOYS.

P.-A. ANCTIL, École Polytechnique, Montréal, Québec, Canada

The purpose of this research is to model the thermodynamics aspects of the Al-Ca-Sr and Al-Sr-Mg systems. Those new alloys are extremely interesting for the car industry. The liquid metal's Gibbs energy is represented by the modified quasichemical model developed at CRCT which takes into account the short ordering in the liquid phase according to the following nearest-neighbors atoms reactions, as example Al-Ca:



Δg_{AlCa} and Δg_{AlSr} being very negatives, the equilibrium is promoting the twosome nearest-neighbors atoms Al-Ca and Al-Sr to the detriment of Ca-Ca and Sr-Sr sets in an aluminum alloy. This high short ordering tendency can be appreciated by the « V » shape of the mixing enthalpy isotherms curves and by the « m » shape of the mixing entropy isotherms curves. The thermodynamic model can be summarized by a Gibbs energy formulation which contains the values of Δg_{AlCa} , Δg_{AlSr} and Δg_{CaSr} :

$$G = n_{Al}g_{Al(liq)}^0 + n_{Ca}g_{Ca(liq)}^0 + n_{Sr}g_{Sr(liq)}^0 - T\Delta s^{config} + \frac{1}{2}n_{AlCa}\Delta g_{AlCa} + \frac{1}{2}n_{AlSr}\Delta g_{AlSr} + \frac{1}{2}n_{CaSr}\Delta g_{CaSr}$$

where T is the temperature expressed in Kelvin, n_i the number of moles of the i element, n_{ij} the number of moles of i - j twosomes nearest-neighbors atoms and Δs^{config} the configuration quasichemical entropy. To better represent the compositions variations of the thermodynamics properties and the phases equilibriums, the values of Δg_{AB} are expressed as T and n_{ij} functions. Numerical values of those functions parameters are obtained by optimization of the experimental data found in literature. H , C_p , a_{Al} , a_{Ca} and a_{Sr} , which are the derivatives of the Gibbs energy function for the liquid solution, can be measured and proved by experimentation. Furthermore, the model can be verified by some experimentations and, once it is proven right, it can be use to calculate industrial applications. Finally, model and parameters databases are part of the **FactSage** software. And it is possible to simulate industrial process relative to those new Al-Mg-Ca-Sr alloys as for example treatment of liquid metal.

POSTER 26

EVALUATION OF KESTELEK BORON TALINGS.

A. GÜL, Y. KAYTAZ and G. ÖNAL, Istanbul Technical University, Istanbul, Turkey

Physical concentration methods are used in Kestelek for the concentration of colemanite. Because of the inefficient process operation tailings containing about 20% B₂O₃ are discarded into the tailing pond. In this study, colemanite tailings sample taken from that tailing pond was treated using scrubbing+screening followed by flotation to recovery the lost boron. Scrubbing tests were carried out for 20 minutes at 65% solids ratio. Scrubbing tests were followed by wet screening using a 0.074 mm screen. Screen over size was obtained with 32% B₂O₃ content and 79.4% recovery. This rougher concentrate was ground and subjected to flotation tests. Sulphonate types of collectors, frother D-14 and depressant dextrine were used in the flotation tests. A concentrate containing 44.5% B₂O₃ was produced with 68.4% B₂O₃ recovery.

POSTER 27

THE KINETICS OF THE DISSOLUTION OF ALUMINUM-MANGANESE COMPACTED POWDERS IN MOLTEN ALUMINUM.

R. MOLAIE, M. SOLTANIEH, M.R. ABOUTALEBI and A. EILAGHI, Iran University of Science and Technology, Tehran, Iran

Manganese is an essential alloying element in the aluminum alloys. Manganese dissolution in molten aluminum is very time consuming and its recovery is relatively low. In the present study the kinetics of the dissolution of the mixture of manganese and aluminum compacted additives in the molten aluminum has investigated at a laboratory scale. The results showed that the dissolution rate and manganese recovery of compacted Al-Mn powder mixture in comparison to the Mn powder was higher. It found that during the dissolution of Al-Mn powder mixture; intermetallic compounds of manganese and aluminum formed. Since the formation of the intermetallic compounds is exothermic, it accelerated the dissolution rate of manganese particles. In this paper the effect of temperature, Mn/Al ratio and mechanical stirring of the bath on the kinetics of the dissolution of manganese in molten aluminum studied.

POSTER 28

THE EFFECT OF MECHANICAL ACTIVATION OF AL-MN POWDER ON THE DISSOLUTION BEHAVIOR OF AL-MN COMPACTS IN MOLTEN ALUMINUM.

R. MOLAIE, M. SOLTANIEH, M.R. ABOUTALEBI and A. EILAGHI, Iran University of Science and Technology, Tehran, Iran

There are several methods for introducing manganese in molten aluminum. Manganese may be added as powder, master alloy or compacted mixture of manganese-aluminum powder. It has been shown that compacting manganese and aluminum powders could improve the kinetics of dissolution of manganese in molten aluminum. In this investigation the mixture of manganese-aluminum powder was mechanically activated using a low energy ball mill, and then the powders were compacted and added to the molten aluminum. It has been observed that the mechanical activation of powders enhanced the rate of the dissolution process significantly. The effect of milling time and Al/Mn ratio was investigated on the dissolution rate of Mn in molten aluminum.

POSTER 29

GAS SLAG REACTION KINETICS IN SLAG CLEANING OF COPPER SLAG.

E. CHEN and K. COLEY, McMaster University, Hamilton, Ontario, Canada

In these modern copper-making industries, slag cleaning furnaces are necessary in order to recover copper from slag. And it has also been concluded that the reduction of copper oxide is alongside with the reduction of iron oxide. With Fe^{3+} being reduced into Fe^{2+} , the viscosity of the slag is decreased, then the reduced matte settle down to the bottom, realize the separation of slag and matte.

The dissociation rates of CO_2 on iron oxide containing slag have been studied by the researchers. In this study, the effect of Cu_2O is studied at different oxygen potentials. It is found that over a range of the rate constant k_f remain constant at higher oxygen potentials. However, when copper is reduced, the rate constant increases, this may be caused by the suspension of small Cu droplets on slag surface

POSTER 30

CHARACTERIZATION OF ACID MINE DRAINAGE LIME TREATMENT SLUDGES USING THE VARIABLE PRESSURE SEM.

K. ROBERTSON, J.A. FINCH and R. GAUVIN, McGill University, Montréal, Québec, Canada

Acid mine drainage lime treatment sludges are produced at many mine sites. Sludge is typically voluminous with elevated levels of metals in the form of hydroxy-complexes. The metal content represents a potential resource if extracted. Acid and amine leaching on a nickel bearing sludge, however, revealed a refractory component. Mineralogical characterization was conducted to identify this component. Analysis using the variable pressure scanning electron microscope has identified two acid leach resistant forms of nickel, the major one is nickel associated with the "hydroxide matrix", with a minor contribution from Ni/S and Ni/O compounds as detrital material. The matrix was shown to exhibit a high degree of homogeneity by comparing x-ray spectra from various areas and with bulk chemical analysis.

POSTER 31

AIR-ASSISTED SOLVENT EXTRACTION.

H.M. TARKAN and J.A. FINCH, McGill University, Montréal, Québec, Canada

Solvent extraction is one of the most widely used processes for the selective recovery of metal ions such as copper, uranium and zinc in hydrometallurgical applications. The main technical drawbacks are the energy to disperse the organic and create high contact area, time for phase separation, limitation to quite strong solutions and loss of reagents (which can pose environmental risk). Air-assisted solvent extraction (AASX) is proposed to address some of these issues. The basis of the concept is the use of a solvent-coated bubble. Compared to conventional solvent extraction, a high specific surface area can be created using less solvent and the natural buoyancy provided by the air core promotes phase separation. The intended application is for large volume, low concentration streams such as acid mine drainage.

POSTER 32

CORROSION OF STAINLESS STEEL IN CONCENTRATED SULPHURIC ACID.

Y. LI, M.B. IVES and K. S. COLEY, McMaster University, Hamilton, Ontario, Canada

Spontaneous active-passive oscillation of UNS S30403 stainless steel in 93.5 wt% sulphuric acid has been studied by electrochemical means. Nickel sulphides intermediate phase theory has been adopted to explain this phenomenon. Recent electrochemical experiments have been able to verify the theoretical existence of the intermediate phase. Polarization results on a passivated steel surface to remove the nickel salts in the theoretically unstable region prove the prediction.

POSTER 33

PREDICTION OF SODIUM ALUNITE SOLUBILITY IN ACID-METAL SULFATE SOLUTIONS USING CHEMICAL MODELING.

M. REID, University of Toronto, Toronto, Ontario, Canada

A chemical model for sodium alunite solubility is constructed for 230-270 degrees Celsius, 0-0.7 molal H_2SO_4 , and 0-0.5 molal Na_2SO_4 . Chemical modeling methodology, using software developed by OLI System Inc., will be introduced. Chemical models are constructed using solubility data for simple ternary metal sulfate-sulfuric acid-water

systems. Regression of this data allows chemical modeling parameters, such as equilibrium constants and ion interaction parameters, to be fitted. The fitted model is then used to predict the solubility of sodium alunite in quaternary acid-metal sulfate solutions. Predictions are compared against experimental data.

POSTER 34

SPOUT EYE FORMATION IN GAS-STIRRED LADLES: A MODEL STUDY.

K. KRISHNAKUMAR and G. A. IRONS, McMaster University, Hamilton, Ontario, Canada

Video investigations on the formation of spout and 'eye' in gas-stirred ladles have been performed in a model vessel for a wide range of operating parameters. Dimensionless correlations are obtained for the axial spout heights in terms of operating variables. Based on experimental data, spout eye formation has been classified into different regimes and the implications are discussed.

POSTER 35

KINETICS OF CO-CO₂ REACTION WITH IRON OXIDE CONTAINING SLAG.

M. BARATI and K. COLEY, McMaster University, Hamilton, Ontario, Canada

The optimization of coal-injection practice involves application of fundamental kinetic, thermodynamic and heat transfer knowledge. A broad literature survey reveals that lack of kinetic data has limited the attempts in developing a comprehensive model for reaction rate evaluation. The reaction of carbon and iron oxide in the slag, is known to occur via gaseous intermediates and it is important to have fundamental data to understand the relative importance of each reaction step on the overall rate.

In this study, the rate of CO₂ dissociation on different slag surfaces is measured using an isotope exchange technique. The influence of iron oxide content, slag basicity, temperature and state of oxidation of slag (Fe³⁺/Fe²⁺) on the reaction rate constant and activation energy is investigated. It will be tried in future works to determine the elementary rate mechanism, thereby develop the comprehensive kinetic model of CO-CO₂ reaction with slag

POSTER 36

PHASE-FIELD MODELING OF STEEL SCRAP MELTING IN A LIQUID STEEL BATH.

J.H. LI, G. A. BROOKS and N. PROVATAS, McMaster University, Hamilton, Ontario, Canada

The effects of scrap sizes, shapes, initial temperatures and oxidized layer on scrap melting behavior in liquid steel were investigated through experimentation and modeling. The formation and re-melting of solidified shells and agglomeration of scrap pieces caused by the interface merging of solidified shells were emphasized in this study. A new convective heat transfer model based on the phase field technique was developed to simulate the melting of scrap with complex geometry and multi-piece scrap melting, which is a significant breakthrough in this research field.

POSTER 37

REDUCTION AND MELTING BEHAVIOR OF IRON ORE-COAL COMPOSITES

M. FATHI and D. CONOCHIE, McMaster University, Hamilton, Ontario, Canada

In recent years it has been shown that iron can be produced from coal and iron ore composites in relatively short time (about 10 min) and low temperature (about 1325°C) where slag can be completely separated from iron. The mechanism of melting and quick separation of iron and slag has not yet been fully understood. According to previous investigators low melting point slag which forms from coal ash and ore gangue plays a very important role in carburization and composite melting behavior. Thus the focus of this study is to determine the effect of ash and gangue compositions on melting behavior and phase separation. Also, the effect of other variables such as particle size, samples size and bulk density are investigated.

POSTER 38

THE RECOVERY OF RHODIUM IONS FROM MINE EFFLUENTS USING SELECTIVE MESOPOROUS ADSORBENTS.

A. ABUGHUSA, School of Engineering Sudbury, Ontario, Canada

Mining of precious metals (PM's) has a huge impact on the Northern Ontario economy. Thus, mining companies are highly invested in the extraction and refining of these valuable elements. Rhodium is obtained as a byproduct in the refining of nickel sulfide ores mined in Sudbury, Ontario, Canada. It is well-known precious metal used for jewellery, catalyst electric and corrosion resistant materials. It gives improved high-temperature strength and oxidation resistance. Since the resources of this metal are limited and because of his wide use, his worth has increased in recent years. The current proposal is to develop a new adsorbent (denoted MP-HMS), were assembled by S[°]I[°] pathway using alkylamines as surfactant (S[°]) and TEOS as the neutral silica source (I[°]), to extract Rhodium in particular and PM's in general from mine effluent streams.

POSTER 39

AN EXPERIMENTAL STUDY ON THE VAPORIZATION OF NIOBIUM OXIDES FROM SLAG MELTS.

Q.J. LI and K. COLEY, McMaster University, Hamilton, Ontario, Canada

The partition of niobium to slag and gaseous niobium oxides vaporizing from metal/slag may cause erratic recovery rates in steelmaking practices. Meanwhile, the metal-oxygen reaction and vaporizing of niobium oxides can cause an alloy loss, affecting the usage of the materials at higher temperatures. In these circumstances, volatility and vapor pressures of niobium oxides need to be known both in steelmaking slag and pure substance. To achieve these aims, an experimental study has been made, employing the transpiration method; of the volatility of niobium oxides in the CaO-SiO₂-NbO_x slag melts at 1873 K. It has been shown that the transported niobium oxide (NbO₂) was measured as a function of flow rate of carrier gas, a mixture of a controlled ratio of CO₂/CO. The weight losses of NbO₂ were to be independent of the flow rate of carrier gas over the range of 40 to 70 cm³/min. The partial vapor pressure of niobium oxide measured in this way was $p_{\text{NbO}_2} = 3.6 \times 10^{-5} \text{ atm}$, which shows a reasonable agreement with literature. The titration method to quantitatively measure the valence state of niobium oxide in slag was employed in combination with a chemical analysis technique suggesting an improved accuracy. The investigation of vapor pressure increasing with Nb⁴⁺ increase indicates that NbO₂ is a more volatile oxide than other types of niobium oxides.

POSTER 40

THE EFFECTS OF VIBRATION MECHANISM AND CHEMICAL ADDITION ON THE DEWATERING OF FINE COALS. F. BURAT, Istanbul Technical University, Istanbul, Turkey

In this investigation the effects of vibration mechanism and addition of chemicals on the dewatering of fine coals was studied. In the case of horizontal vibration only the moisture content was reduced from 61% to 42.3% where screen inclination was 3.5 degrees and the vibration frequency was 800. When vertical vibration was additionally used the moisture content was reduced to 41.5%. In the case of chemicals addition SDS, CTAB, Umectante B-70 and kerosene were used. The best results were obtained with 5 g/t of CTAB at the natural pH of 7.25. On the addition of CTAB and applying additional vertical vibration the moisture content decreased to 40.7%. Furthermore, thresholds 15 cm in between were placed on the screen to increase dewatering efficiency. The test findings showed that with the addition of thresholds the moisture content was dropped to 39.9%.

POSTER 41

PRECIPITATION OF BORON FROM THE TINCAL CONCENTRATOR EFFLUENTS. O. KOKLILIC, Istanbul Technical University, Istanbul, Turkey

In the scope of this study experiments were conducted for the recovery of boron by precipitation from the effluents of Kürka Borax Concentrator. Precipitation experiments were made in two steps. In the first step; factors like quantity of the precipitant reagent such as Ca(OH)₂, MgO and Ca(OH)²⁺MgO, initial pH value, agitation time, and precipitation time were studied in order to understand their effects on the precipitation mechanism of boron. The optimum conditions found after the first step of beneficiation experiments were; 20 kg/m³ of Ca(OH)₂ addition, initial pH of 6 and a precipitation time of 4 hours. As a result of test conducted under optimum conditions 87% of boron was precipitated and the boron concentration in the solution was reduced to 0.51 g/L. In the second stage of the investigation Ca(OH)₂ was used as precipitating reagent and Al₂(SO₄)₃·18H₂O was used as pH regulator. The optimum conditions found after the second step of beneficiation experiments were; 20 kg/m³ of Ca(OH)₂ and 60 kg/m³ Al₂(SO₄)₃·18H₂O addition. As a result of test conducted under optimum conditions 74.5% of boron was precipitated and the boron concentration in the solution was reduced to 0.13 g/L. According to the overall precipitation test results, the total boron precipitation was found almost 96.7%.

POSTER 42

FLASH GOLD FLOTATION AS FIRST STEP OF THE GRAVIMETRIC CIRCUIT AT THE DOYON MINE. M.-A. HARBEC, Laval University, Québec, Québec, Canada

The Doyon mine had recently put in place a gravimetric circuit to intercept fine gold that normally pass free cyanide leaching. Tests have been made improve this latter. Flash flotation is one of the interesting processes. From batch tests, it is known than flotation is possible on Doyon oxides. But flotation is a costly and complex process. This poster shows for and against points that must be deepen before starting further investigations on flash flotation feasibility.