Global Symposium on Recycling, Waste Treatment and Clean Technology

REWAS 2008

FINAL PROGRAM

Organized by

TMS

tecnalia
Corporación Tecnológica

MMIJ

SME

European Commission

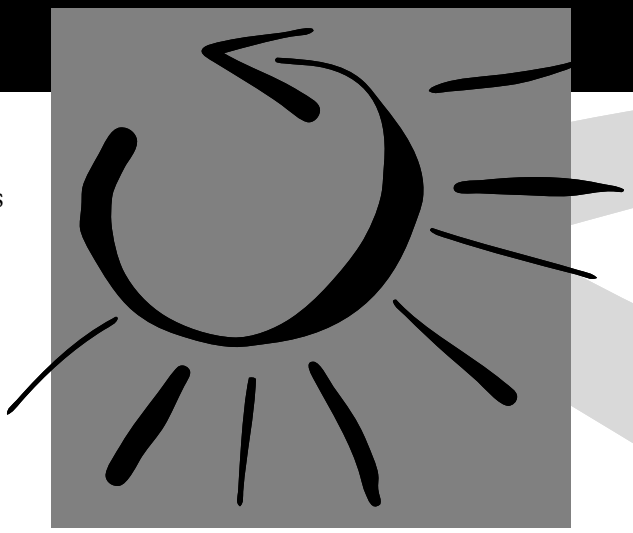
EMPA
Materials Science & Technology

Incorporating

- Fifth International Symposium on Recycling of Engineered Materials
- R'08 – World Congress on the Recovery of Materials and Energy for Resource Efficiency

October 12-15, 2008
Hilton Cancun Golf & Spa Resort
Cancun, Mexico

Welcome to REWAS 2008!



REWAS 2008
Global Symposium on Recycling, Waste Treatment and Clean Technology

This year's **Global Symposium on Recycling, Waste Treatment and Clean Technology** is the third in a series of international conferences addressing the continuing globalization of environmental protection through progress in **recycling technology, re-engineering of the production system, and clean technologies.**

As an attendee, the benefits are tripled as REWAS 2008 incorporates the Fifth International Symposium on Recycling of Engineered Materials, and R '08 - World Congress on the Recovery of Materials and Energy for Resource Efficiency.

Be sure to take advantage of all REWAS has to offer you.

Your registration includes:

- Technical Sessions
- 2 Workshops
- Proceedings CD-ROM
- 6 Networking Breaks
- 2 Receptions
- Conference Reception and Dinner
- Exhibition

Proceedings

The complete REWAS 2008 proceedings, including R'08 and the Fifth International Symposium on Recycling of Engineered Materials, has been produced on CD-ROM. Each attendee paying the full registration fee receives a free proceedings CD-ROM. (Student registration does not include the proceedings CD-ROM). Proceedings CD-ROMs may also be purchased at the REWAS registration desk.

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TMS Recycling and Environmental Technologies Committee

Sunday • 1 to 2:30 p.m. • Coral Room

Anyone interested in participating on this committee is encouraged to attend this meeting.

Welcome Reception

Sunday • 6 to 7:30 p.m. • Miramar Garden

Enjoy hors d'oeuvres and cocktails with fellow attendees.

Poster Reception

Monday • 6 to 7 p.m. • Miramar Foyer

View the technical posters and discuss the work with the authors.

Conference Reception and Dinner

Tuesday • 6 to 9 p.m. • Caesar Room

Free to all registered conference attendees. Tickets for guests may be purchased at the REWAS registration desk.

Closing Ceremony

Wednesday afternoon • Miramar Foyer

Take advantage of light refreshments and meet with colleagues you have not had a chance to connect with all week.

Networking Breaks

Monday, Tuesday and Wednesday mornings and afternoons • Miramar 1 and 2

Take a break and visit with exhibitors to learn about the latest products and services available in your field.

Exhibition

Monday, Tuesday and Wednesday • Opens at 10 a.m. • Miramar 1 and 2

Visit the exhibition to see what is new in the fields of recycling, recovery of materials, and resource efficiency in energy.

Plenary Speakers

Monday • 9:15 to 10:15 a.m.

- Ray D. Peterson, Aleris International Inc.
  "Recycling and Waste Treatment in the Aluminum Industry"

- Ramana G. Reddy, University of Alabama
  "Lightweight Metals Recycling via Ionic Liquid Electrolytes"

Tuesday • 9 to 10 a.m.

- Xaver Edelman, Mitglied Direktion EMPA
  "From R'07 to R'09: World Resources Forum as a Platform for Resources Productivity"

- Brajendra Mishra, Colorado School of Mines
  "Societal Impacts of Waste Management"

Wednesday • 9 to 10 a.m.

- J. Michael Huls, California Resource Management Institute
  "Moving Business to Clean Production and the Triple Bottom Line"

- Heinz Werner Böni, EMPA
  "E-Waste Recycling - A Relevant Contribution to Closing Global Material Cycles"

Workshops

The following workshops are included as part of your REWAS registration.

Zero Waste Workshop
Conducted by the California Resource Management Institute
Monday • 2:15 to 6 p.m. • Miramar 4

Don't miss the accompanying International Papers on Zero Waste Panel Discussion
Tuesday • 10:30 a.m. to 12:30 p.m.• Caesar 6

Challenges and Strategies for Management of Electrical and Electronic Waste in Latin America and the Caribbean
Supported by EMPA, SUR, and United Nations "StEP" (Solve the e-Waste Problem)
Tuesday • 10:30 a.m. to 12:30 p.m./2 to 6 p.m. • Miramar 4

Badges
REWAS badges received on-site must be worn to gain access to all conference events: technical sessions, workshops, exhibition, social functions, etc.

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Americans With Disabilities Act
TMS strongly supports the federal Americans with Disabilities Act (ADA) which prohibits discrimination against, and promotes public accessibility for, those with disabilities. In support of ADA, we ask those requiring specific equipment or services to speak with a TMS staff person at the REWAS registration desk.

Refund Policy
The deadline for refunds was September 15. No refunds are issued after the deadline.

Exemption of Mexican Federal VAT Tax
As of January 1, 2004, the Mexican Federal Government stipulates that all international meetings, congresses, conventions and expositions be granted an exemption on the VAT tax 10 percent for accommodations. In order to qualify for this, the following is required:

- Individual guests must present their migratory documentation (FME for foreigner) and passport upon check-in. Both documents will be photocopied and attached to the room's folio.
- Every participant must sign his/her registration card upon arrival.
- The hotel will also keep a copy of the authorized payment method: foreign (non-Mexican) credit card, foreign (non-Mexican) check or wire transfer from a foreign bank.

Optional Tours
Tickets are still available for the shopping tour on Tuesday and the tours to the Mayan Ruins of Tulum and the Natural Aquarium of Xel-Ha on Thursday. Purchase tickets at the Cancun information and tour desk, near REWAS registration, Monday through Thursday.

Session Listing

Monday Plenary Session

Monday AM
October 13, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Subodh Das, Phinix LLC

9:00 AM Introductory Comments

9:15 AM Plenary
Recycling and Waste Treatment in the Aluminum Industry: *Ray Peterson*[1]; [1]Aleris International Inc

Recycling has long been practiced in the aluminum industry due to the inherently high value of the metal. Both manufacturing scraps and post-consumer scraps find their way back into the metal stream. As an industry we also try to minimize our by-product materials requiring waste treatment. The aluminum industry can be broken down into four major divisions: • Bauxite to Alumina • Alumina to Aluminum Metal • Aluminum Metal to Useful Product • End-of-Life Product to Aluminum Metal. Each of the four major sub-areas will be examined for recycling and waste minimization. Significant progress has been made in reducing a number of of the larger by-product streams, but further effort is still needed in several areas. In addition to new technologies, both economics and local laws will dictate the degree of progress made on eliminating many waste streams.

9:45 AM Plenary
Lightweight Metals Recycling via Ionic Liquid Electrolytes: *Ramana G. Reddy*[1]; [1]The University of Alabama

10:15 AM Break

Case Studies in the Development of Waste Treatment Technologies I

Monday AM
October 13, 2008

Room: Caesar 8
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Ryan Robinson, Luleå University of Technology

10:45 AM Keynote
Case Study: Quality Improvement of Recycled Aggregates from a Construction and Demolition Waste Recycling Pilot Plant: *Dora Algarvio*[1]; Maria Margarida Lima[1]; Maria Lucelinda Cunha[1]; [1]Universidade Nova de Lisboa/Faculdade de Ciências e Tecnologia

The main goal of the present work is the quality improvement of the recycled aggregates produced by a construction and demolition waste (C&DW) recycling facility located in Montemor-o-Novo , Portugal. The recycling process was developed on a pilot plant scale with 50 t/h of capacity. Process operations are the hammer mill comminution, magnetic separation and screening. In order to improve the knowledge on the C&DW, a characterization procedure was implemented by hand-sorting, magnetic and density separation on representative samples. On the other hand, to improve the quality of the produced aggregates, the bar screen size fractions were analysed, according to the Portuguese Standard (NP EN 933-1 2000). Wood was identified as the critical contaminant, representing 17% by weight of the total contaminants. Sieving results showed that about 97%, 76%, 56%, 98% and 57% were on the correct size range, which lower results are probably due to the type of screens and/or the material characteristics of the recycled aggregates.

11:10 AM
Adsorption of Molybdenum in Nitric Acid Solution by Using Pb-Fe Based Adsorbents: *Gjergj Dodbiba*[1]; Takahiro Kikuchi[2]; Toyohisa Fujita[1]; [1]University of Tokyo; [2]Japan Atomic Energy Agency

In order to separate molybdenum (Mo) from high-level radioactive liquid waste (HLLW), Pb-Fe based adsorbents were synthesized. The adsorbents were precipitated by adding sodium hydroxide in mixture of 1M ferric nitrate and 1M lead nitrate aqueous solutions. Each precipitate was then filtered, dried and ground by using an agate mortar with pestle to obtain a fine powder, which has been used as an adsorbent. Two main parameters were considered when synthesizing the adsorbents, i.e. the pH value at precipitation of adsorbent precursor and the calcination temperature of Pb-Fe adsorbent. Moreover, the structures of the synthesized adsorbents were investigated by means of an X-ray diffractometer. The experimental results indicated that the calcination temperature of the Pb-Fe based adsorbent has a great influence on absorption capacity of the adsorbent for Mo. It was found that when the Fe-Pb adsorbent was calcinated at 500°C, the Mo removal ratio was the greatest.

11:30 AM
Active Carbons and Their Reactivation in Non-Ferrous and Noble Hydrometallurgy: *V. M. Mukhin*[1]; [1]Elektrostal Research and Production Association "Neorganika"

The progressive pollution of the environment made ecological safety an important constituent of national safety as a whole. An essential progress in ecological problems solving may be provided with mass use of adsorption technologies on the basis of active carbons (AC), directed expressly toward application in environmental protection special fields. The analysis dictated by market requirements and economic situation permitted to determine and found key directions of AC production and volume gain of their application for biosphere protection. On the other hand, volume gain of AC application required the technology and equipment development for waste carbon sorbents reactivation. Thermal reactivation with the help of overheated vapor as an oxidant was created for the fields of AC application with the big tonnage: drinking water purification, solvent recuperation, gold hydrometallurgy, alcohol production and some other kinds of industry.

11:50 AM
Assessment of Ladle Slag as Binder Alternative for Cold Bonded Briquettes: Daniel Adolfsson[1]; *Ryan Robinson*[2]; Jelena Blagojevic[3]; Fenwei Su[3]; [1]SSAB Merox AB; [2]Luleå University of Technology; [3]SSAB Tunnplåt AB

Cold bonded briquetting of steel plant by-products has proven to be a viable recycling alternative concerning technology, economy and environment in both the traditional blast furnace route and the direct reduction process. A critical parameter in cold bonded briquettes is the type and amount of binder used during production. The binder material must meet certain quality requirements concerning low and high temperature strength, chemistry and economy. Currently, SSAB Tunnplåt uses ordinary Portland cement (OPC) as binder in their cold bonded briquettes. In order to improve binder quality and possibly decrease OPC dependency, a binder feasibility study has been conducted concerning an internal by-product, ladle slag, as a supplement and/or partial substitute for OPC. Several characterization techniques have been used to study the behaviour of ladle slag, these include: XRD, XRF, SEM, glass content analysis, calorimetric analysis, particle size distribution and thermo-chemical stability considerations concerning the CaO-Al2O3-SiO2 system.

Clean Technology and Reengineering of Current Processes I

Monday AM
October 13, 2008

Room: Caesar 5
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Corby Anderson, Montana Tech of the University of Montana

10:45 AM Keynote
Influence of Alkali Ions on Ilmenite for the Extraction of Titanium Dioxide: Abhishek Lahiri[1]; *Animesh Jha*[1]; [1]University of Leeds

Roasting of ilmenite has been studied in detail using the carbonates of Li, Na and K. The rates of roasting reactions are compared together with the diffusion of alkali in ilmenite structure and, the consequent removal of iron ions via the replacement with alkali ions in the lattice. The influence of ionic radii of alkali ions on the strain in ilmenite lattice has also been analysed in terms of columbic interaction between the three cations and O2- anions. The proposed crystal chemistry approach has been applied for the beneficiation of ilmenite for producing synthetic rutile having purity great than 95% TiO2.

11:10 AM
Bioleaching of Copper Sulphides Flotation Concentrate Using Consortium of Mesophilics and Thermophlics Microorganisms: Renata Lima[1]; *Luis Sobral*[1]; Carlos Souza[1]; Selma Leite[2]; Paulo Silva[3]; [1]Center for Mineral Technology - CETEM; [2]Federal University of Rio de Janeiro; [3]Caraíba Mining Company S/A

The use of mixed cultures of acidophilic microorganisms that act in different temperature ranges, aims at speeding up the digestion of chalcopyrite, highly refractory sulphide mineral, the major mineral in the flotation concentrate of Caraíba Mining Co., with an attractive processing cost. The concentrate under consideration contains mainly chalcopyrite (CuFeS2) and bornite (Cu5FeS4) with contents of, approximately, 70 and 30%, respectively. It was observed in this study, the performance of consortium of mesophilics, moderate and extreme thermophlics microorganisms, in the oxidation of the aforementioned sulphides minerals, evaluating operational parameters such as pH of the leaching solution, the reaction temperature and redox potential, with consequent extraction of 80% of the concentrate copper content within 60 days of bioleaching. Such high copper extraction was achieved in column bioleaching tests.

11:30 AM
Desulfurization during Calcination of Anode-Grade Petroleum Coke: *Xiping Chen*[1]; Jiemin Zhou[1]; Wangxing Li[1]; [1]Chalco

Desulfurization methods suitable for anode-grade petroleum coke (coke for short) used in primary aluminum industry are coke desulfurization during calcination, desulfurization in soakage and desulfurization in mediums. Coke desulfurization during calcination is discussed in this paper. Influences of calcination temperature, holding time and coke granularity on coke desulfurization were discussed. Experimental results show that calcination temperature has a remarkable influence on coke desulfurization. When the temperature is high enough desulfurization ratio of coke can reach 85% only by calcination. Holding time has a definite influence on coke desulfurization, but desulfurization ratio is low at the temperature of 900~1300°C. The influence of holding time is obvious when calcination temperature surpasses 1400°C. The influence of coke granularity is smaller compared with calcination temperature and holding time.

11:50 AM
Development of Ion-Selective Membranes of Polyaniline (PAni) and Sulfonated Polystyrene (SPS) and High Impact Polystyrene (HIPS) for Application in Electrodialysis to the Treatment of Industrial Effluent: Marcela Pinheiro Proença[1]; Betina Hansen[1]; Marco Antônio Siqueira Rodrigues[2]; Carlos Arthur Ferreira[1]; *Sergio Monteiro*[3]; [1]Universidade Federal do Rio Grande do Sul; [2]Centro Universitário Feevale; [3]State University of the Northern Rio de Janeiro - UENF

Nowadays, the concern with the reduction of industrial pollution has motivated researchers to found out new technologies for treatment of industrial waste. The clean technologies, as electrodyalisis, are capable of treating these residues, minimizing the impacts when they are discarded directly on the environment. Membranes of SPS/HIPS, PaniCSA/SPS/HIPS, SPAM/SPS/HIPS and PaniTSA/SPS/HIPS were developed using chemical mixture method. Membranes were characterized by Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA), Dynamic Mechanical Analysis (DMA) and Scanning Electronic Microscopy (SEM). Membranes were submitted to electrical polarization and electrodialysis techniques analysis at NaCl and KCl solutions, in order to determine ionic transport through the membranes. Results were compared with commercial membranes. The average extraction percent for Na+ ions obtained by membrane was around 20%.

12:10 PM
Evaluation of Ambient Impacts and Identification of Chances of Implementation of Cleaner Production in a Plant of Railroad Wagons: Ana Enders Nunes Vieira[1]; Ênio Machado[1]; Diosnel Lopez[1]; Adriane Lawisch[1]; *Jorge Ribas Moraes*[1]; [1]Universidade de Santa Cruz do Sul

In this work was measured environmental impact actions in industrial activities of companies who produce wagons railroad, offering an instrument of management for the improvement of the ambient performance of the same ones. They had been identified and analyzed twenty and five impacts actions and/or processes by means of visit "in I lease" and for the method of the Matrix of Interaction of the ambient problems for half the physicist, biotic and antropic. Of the gotten results, the main verified ambient problems in the enterprise had been: use of natural resources and energy sources you did not renew, generation of noises, emissions of particulates materials, occupational risk and water wastefulness. Evaluation of this impacts is of great importance for the identification of chances of implementation of cleaner production (CP) and are instruments of improvement of the ambient conditions and the productivity.

12:30 PM
Modeling and Design of the Composting and Vermicomposting Processes: *Tasneem Abbasi*[1]; Sankar Ganesh[1]; Gajalakshmi S.[1]; S. A. Abbasi[1]; [1]Pondicherry University

This paper reports an effort aimed at clearly defining the mechanism of the vermicomposting process and to model it. This, in turn, has been made the basis for developing rational criteria with which vermireactors are to be designed and operated in a manner that maximizes the process efficiency and minimizes the product cost. A detailed assessment of the mechanism and impact of the various steps associated with composting and vermicomposting was carried out, in the context of the experiments done earlier by us, as also the work published by others. It is seen that composting and vermicomposting are essentially different types of processes involving different bioagents, process conditions, reactor operation strategies, and process control parameters. Hence, to achieve optimal results, the two processes should be run in isolation; composting should always precede vermicomposting. The two should never be run in combination, as is often done, especially in developing countries.

Environmental Issues Related to Waste Storage and Recycling I

Monday AM
October 13, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Preston Holloway, Dynatec Technologies

10:45 AM Keynote
Indonesian Palm Oil Bio-Wastes and Its Environmental Impacts: *Kiichiro Hayashi*[1]; [1]EcoTopia Science Institute, Nagoya University

Indonesia is one of the world largest palm oil producers after Malaysia with over 12 million tons of crude palm oil(CPO) production in 2004. About 60% of CPO is exported. Among the rest of it, around 30% is used for cooking oil followed by 7% of oleochemical, 2% of soap and 1.6% of margarine. In the process of CPO production, many types of bio-wastes are generated in plantations and CPO mills. In plantations, fell trunk, fronds at felling and annual pruning are the main bio-wastes. Empty fruit bunch(EFB), fibres and shells are generated in CPO mills. One part of fibres and shells are, in some cases, utilized for mill boiler fuels. The purpose of this study is to clarify environmental impacts of palm oil industry in Indonesia. This paper conducted surveyed on selected palm oil factories in Indonesia and assessed the impacts of the environment.

11:10 AM
Ageing Investigation of Steel Slags from EAF (Electric Arc Furnace) Processes: *Fredrik Engström*[1]; Margareta Lidström Larsson[1]; Caisa Samuelsson[1]; Bo Björkman[1]; [1]Luleå University of Technology

Large amounts of by-products are generated by the Swedish steel industry each year. The EAF-process generates about 400 000 ton of slag, from which 80% is deposited. An alternative to deposit is to use slag as road construction material. However, heavy metal content in the slag can be a problem. The aim of this work was to investigate how stabile these materials are when ageing and kept outside. Five different EAF-slags from domestic steel plants were used in this study. The materials were characterised after 0, 6, 12, 18 and 24 month to evaluate the ageing process. Scanning electron microscope (SEM), x-ray diffraction pattern (XRD) and a standard test for leaching were used. The changes in behaviour differ between the five materials. The total leachability decreases with time. CaCO3 is formed on slag surfaces as CaO reacts with moister and CO2 in the air.

11:30 AM
Colloid Facilitated Heavy Metal Mobilization from Incinerator Ashes: *Rainer Köster*[1]; Tobias Wagner[1]; Wolfgang Ferstl[1]; Markus Delay[1]; Wolfgang Höll[1]; [1]Institut für Technische Chemie, Bereich Wasser- und Geotechnologie, Forschungszentrum Karlsruhe GmbH

The mobilization of contaminants from industrial residues like ashes from municipal solid waste incinerators in case of leaching is investigated world wide. In classical leach tests only soluble species are considered. In addition the geochemical behaviour of residues have to be completed by assessing the mobilization via colloidal particles. This transport is well known from natural aquatic systems. Quantification of aquatic colloids is associated with considerable difficulties, because they are often found in low concentrations and in a size distribution where small particles with diameters below 0.1 µm predominate. In the past years, the Laser induced Breakdown Detection (LIBD) has been developed as a novel sensitive method for quantifying colloids. Column leaching experiments with directly coupled LIBD were used to quantify the release of heavy metals and colloids out of bottom ashes. Some typical colloid bound heavy metal concentrations in the leachate are in some cases exceeding the limits defined by German authorities. The LIBD with a flow-through cell allowed to assign absolute values to colloid size and concentration.

11:50 AM
Hyrdometallurgical Extraction of Rhenium from Lead Slime of Copper Production: *Ashraf Amer*[1]; [1]Environmental Science Department Faculty of Science

It has been studied the rhenium recovery from lead slime of copper manufacture by hydrometallurgical method in the presence of hydrogen peroxide. The transition of rhenium into solution is drastically increased at the first 30 min. of leaching when the hydrogen peroxide concentration increases from 1 up to 34. The data on the effect of hydrogen peroxide concentration indicate that, the increase of H2O2 concentration from 1.0 to 6.0% lead to increase of rhenium recovery from 84.5 to 98.6%. In accordance with the date obtained rhenium recovery is increased from 65.0 to 98.6% with the temperature increase from 50 to 100°C at the leaching duration 60 min. and solid/liquid 1:3. The leaching reaction constant is calculated on the first-order equation. It is shown that, the reaction constant is increased from 4.10 to 9.70, 10-2 as the temperature increases from 50 to 100°C.

12:10 PM
Pollutant Characterization from a Municipal Waste Disposal Site (Navarro) in Cali, Colombia: *Simona Regenspurg*[1]; Christian Ludwig[1]; Norberto Benitez[2]; Fabian Mendez[2]; [1]Ecole Polytechnique Fédérale de Lausanne/Paul Scherrer Institut; [2]Universidad del Valle

Navarro is the main garbage dump in the city of Cali (Colombia). Operated since the late 1960s it collects about 1.600 tons of waste daily. The environment surrounding Navarro is highly contaminated and the pollutants released by the dump threaten human health in the adjoining neighborhoods. The goal of our project is to identify major pollutants released from the dump and their distribution in the surrounding ecosystem. In a first phase of the sampling and analysis program landfill leachate was collected and screened for heavy metals and for the most common persistent organic pollutants. This allowed us to identify the most relevant compounds on which we focused in a more detailed second phase investigation. These compounds were quantified in the vicinity of the landfill (groundwater, surface water, drinking water and soil) to get information on their mobility and possible pathways into the human body.

General Recycling and Solid Waste Processing: Aluminum By-Product Recovery and Secondary Production I

Monday AM
October 13, 2008

Room: Miramar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Guozhu Ye, MEFOS

10:45 AM Keynote
Alumina Surface Material from Aluminum Solid Waste: *Tarek Abd El Hamid*[1]; Soheir El Reefy[2]; Monira Ghoniem[1]; Saad Mohamed[3]; [1]Tabbin Institute for Metallurgical Studies; [2]Atomic Energy Authority; [3]Faculty of Science Ain Shams University

Aluminum solid waste produced as bi-product in Mite-Ghamer industrial cluster for aluminum household industry. The cluster located 150km North-East Cairo-Egypt. The waste was accumulated during manufacture process in surface treatment step, it represents 3% of total production capacity with total of 1500tons waste annually, characterized by high alumina contents and high alkalinity, disposed it create a serious environment problems to local community. The aim of this study is to recover high purity surface fine alumina from previous mentioned waste.Recovery problems originated from contamination with organic lubricants used in manufacture processes. Aluminum ions in waste cake separated as sodium aluminates, co-precipitated and thermal decomposed. High purity alumina material with originated particle size 0.125-0.420mm and apparent density 0.3gm/cm3 was obtained with specific surface area 139.07m2/g. The alumina produced is very suitable for application as absorber and supported catalyst.

11:10 AM

DC Electric Arc Rotary Furnace: Biserka Lucheva[1]; *Tzonio Tzonev*[1]; [1]University of Chemical Technology and Metallurgy

A unique DC electric arc rotary furnace with capacity 150 kg has been designed and constructed for the recycling of low-quality scrap and aluminum dross. The main constructive feature of this furnace is that the axially positioned graphite electrodes (cathode and anode) are placed 100 mm away from the rotation axis of the furnace. A specific characteristic of the construction is the possibility one of the electrodes (the anode) apart from moving axially (parallel to the furnace axis) to move at 90° outside the working space. High recovery rate of metal aluminum from aluminum dross (92%) was realized in this furnace. This is the reason for construction of industrial DC electric arc furnace.

11:30 AM

Alumina Surface Material from Aluminum Solid Waste and Its Catalytic Application: *Tarek Abd El Hamid*[1]; Suzan Ali[2]; [1]Tabbin Institute for Metallurgical Studies; [2]Faculty of Girls for Science and Education - Ain Shams University

Treatment of industrial waste materials is created serious problem in Egypt. Aluminum sludge is generated as a by-product from aluminum household industry which contain significantly high alumina content exceeding 90%. This by-product randomly disposed and creates serious environment problems to locate community. To develop the treatment process of this material, the recovery of high purity alumina and identify the potential application is being the primary objective. This paper represents the recovery process of alumina process waste sludge. High purity alumina material <99,8% aluminum oxide with originate particle size 0.125-0.420mm and apparent density 0.39g/cm3 was obtained with a specific surface area 139m2/g. Alumina produced was modified by cerium oxide doped alumina. The catalytic activity and selectivity was investigated in conversion of isopropanol via dehydrogenation reaction yielding only acetone, indicating an excellent selectivity for dehydrogenation. The presence of 10% CeO2 increase in the catalytic activity of 82% for the originated alumina.

11:50 AM

Elkem Spent Pot Lining Recycling Project: *Finn Olesen*[1]; [1]Elkem Bjoelvefossen AS

Elkem has developed a process that utilizes SPL as a raw material for pig iron production. This process will be demonstrated in industrial scale during 2008. The process developed produce iron, and the reduction material used, is the carbon present in the SPL. The iron source could be either virgin iron ore or waste/recycled material from the steel industry. The SPL- refractory and bath material is dissolved in the slag produced. The slag is designed so that any leaching of environmentally dangerous elements is minimized. This process can in addition to SPL, consume other types of waste derived from the primary production of aluminium. Elkem intends to supply this demo project with SPL and other waste products from external sources, domestic as well as international ones. The REWAS 2008 presentation will present the results from the industrial demo.

12:10 PM

Hazardous Spent Potlining from Aluminum Smelters and Its Countermeasures in China: *Xiping Chen*[1]; Wangxing Li[2]; [1]Zhengzhou Research Institute of Chalco; [2]Chalco

Spent potlining is unavoidable solid residue from aluminum industry. About thirty kilograms spent potlining is discharged in China to produce per ton primary aluminum. Spent potlining has high level soluble fluorides and cyanides so that it brings heavy pollution to environment. It is prohibitive to keep a large amount of spent potlining in open air because it will lead concentrated pollution to local soil and water source due to hydrated reactions between spent potlining and rain water/moisture in air. Landfill may solve pollution of spent potlining provisionally, but it is difficult to be accepted by aluminum smelters because of its high investment, troublesome monitoring and perennial maintenance. Detoxifying of spent potlining not only can remove deleterious fluorides and cyanides in SPL, but also can make fluorides in SPL recycle inside aluminum electrolysis process, at the same time benign SPL solid residue can be recycled and ready for cement production.

General Recycling and Solid Waste Processing: EAF Dust

Monday AM — Room: Caesar 4
October 13, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Bo Bjorkman, Lulea University of Technology

10:45 AM Keynote

Recovery of Zinc from EAF Dust – Pilot Experiences at MEFOS: *Guozhu Ye*[1]; [1]MEFOS

Few of the numerous alternative methods proposed for zinc recovery from EAF dust have passed beyond the laboratory tests. The paper will give you insights to the known and unknown concepts that have been tested at MEFOS in the past 15 years. The innovative aspects of these concepts will be shown and the major results will be highlighted. These include the following concepts: - Production of ZnO product with low halide content for electrowinning using a DC furnace with hollow electrode (1990-1995). - Production of a bypass filter dust containing more than 50%ZnO by injection of EAF dust to the electric arc furnace during refining combined with a bypass filter system. - Elimination of zinc ferrite by CaO treatment for electrowinning with EZINEX process. - Selective reduction of iron oxide in zinc ferrite for simultaneous recovery of ZnO and metallic iron.

11:10 AM

A Study on Recovery of Metallic Values from EAF Flue Dusts: Hakan Morcali[1]; *Bora Derin*[2]; Adnan Aydin[1]; Onuralp Yucel[2]; [1]Marmara University; [2]Istanbul Technical University

The steelmaking industry which uses electric arc furnaces (EAF) generates approximately 250.000 tons of EAF flue dusts annually in Turkey. These flue dusts contain valuable metals such as zinc, iron and lead. For example, if these flue dusts can be treated efficiently, disposal problems certainly decreases and annually almost 40.000-75.000 tons of zinc can be recovered. In this study, powder and pellet form of EAF flue dusts taken from a steel mill were carbothermally treated in a temperature controlled pilot scale rotary furnace via carbothermal reduction in order to investigate the reduction behavior of Zn, Fe and Pb. Temperature (900-1000-1050 and 1100°C) and time (0-90 minutes) were selected as reaction parameters. The chemical and XRD analysis were also performed in the residues. The content of Fe, Zn, Pb in EAF dust are 30, 20, 4 wt % respectively. As a primary research on the slag-refining mechanism of Zn and the thermodynamic behavior of Zn in Fe, a positive deviation from Raoultian Solution at the carbon saturated region was acquired according to the analyzed data of the activity coefficient of Zn.

11:30 AM

Reduction of Zinc Ferrite Contained in Steelmaking Processes Dusts by $CO - CO_2$ Gas Mixtures: *Mery Gómez*[1]; [1]Pontifícia Universidade Católica do Rio de Janeiro

In this work the reaction between an equimolar synthetic zinc ferrite sample and a mixture of CO and CO_2 gases is studied to evaluate the effects of temperature reaction and CO content, on the reduction of zinc ferrite, iron III oxide and zinc oxide. The temperature ranged from 1073 to 1373K, and the gas mixtures from 50% and 100% of CO. These tests were accompanied by physical, chemical, strutural and microscopic characterizations of the zinc ferrite generated in laboratory. It was observed that the temperature and CO content were the main factors affecting the zinc ferrite reduction.

11:50 AM

Treatment of BF and BOF Dusts by Oxidative Leaching: *Ma. de Jesus Soria-Aguilar*[1]; Francisco Carrillo-Pedroza[1]; Sandra Preciado-Nuñez[1]; [1]Universidad Autonoma de Coahuila

Dust originated from the Iron Blast Furnace (BF) and the Basic Oxygen Furnace (BOF) containing alkalis and zinc are not completely recycled because due affects the process efficiency. These types of dust represents

an economical lost as a consequence of values contents of iron and carbon. Several processes in aqueous media have been developed to treat the steelmaking dust. This work presents a laboratory study for reduce zinc and alkali containing in BF and BOF dust, using different acid and alkaline solutions and oxidants as ozone. The results obtained show that the elimination of zinc and alkalis can vary from 5% to 80% depending on the treatment conditions (the solution, the oxidant and the temperature). The dust obtained from this treatment can to be recycling to the steelmaking processes to recovery iron and carbon values.

12:10 PM

Zinc Oxide from Recycling Processes as a Source for Electrolytic Galvanising: *Juergen Antrekowitsch*[1]; [1]University of Leoben, Austria

Typical zinc oxides recovered from wastes like steel mill dusts and neutral leaching residues are of a low quality because of impurities like fluorine, chlorine, lead and others. Therefore, they are not comparable to technical grade zinc oxides. Some new developments try to establish processes where higher qualities of the product should be achieved. These zinc oxides are not only supposed to be an input material for electrolytic zinc production. Far more, they should find their way into the zinc oxide market as a substitute for technical grade zinc oxides. Furthermore, a new field of application for these oxides has been investigated. Because of a higher acceptance concerning different impurities in relation to zinc winning electrolyses, a use in electrolytic galvanizing shows an interesting option. Therefore, the effect of different impurities especially on the quality of the zinc layer, the current efficiency and the possible galvanizing speed were studied.

General Recycling and Solid Waste Processing: Magnesium

Monday AM — Room: Caesar 6
October 13, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Neale Neelameggham, US Magnesium LLC

10:45 AM Keynote

Design for Recycling - A Key to Sustainable Magnesium Application: *Christina Meskers*[1]; Markus Reuter[2]; U. Boin[1]; [1]Delft University of Technology; [2]University of Melbourne

The increasing use of coated magnesium in consumer products results in creation of coated Mg scrap during product manufacture and after End-of-Life product treatment. Currently this material is not recycled, leaving a material resource unused. Closure of the magnesium cycle in a sustainable manner is necessary. In order to do so, the effect of coatings on the recycling process has to be quantified, predicted and minimized. For this purpose parameters and metrics have been developed, based on first principles and detailed understanding of the recycling process. The parameters characterize the coated magnesium and are combined into a single metric. This 3D metric enables quantitative assessment of the recyclability and links coating design, product design and recycling to each other in a visual manner. The parameters that form the metric can be measured and predicted, hence a sound (engineering) basis for Design for Sustainability of coated magnesium is provided.

11:10 AM

Advanced Solid-State Recycle of Magnesium Alloy Wastes by Repetitive Severe Plastic Working for High-Strengthened Wrought Materials: *Katsuyoshi Kondoh*[1]; Kenshi Kawabata[1]; Junko Umeda[1]; Kantarou Kaneko[2]; Mitsuji Ueda[3]; [1]Osaka University; [2]Kurimoto Company; [3]KS Technos Company Ltd.

Direct recycling process of in-house scraps of AMX602 magnesium extruded alloy (Mg-6Al-0.2Mn-2Ca), used as the gate bar used in Electronic Toll Collection (ETC) of Japan high-way system, has been established by roll-compaction (RCP) process. It enables to serve raw chips, having refined grains and intermetallics, via no re-melting process. They are easily consolidated by hot extrusion, and their wrought alloys show superior balancing properties of high strength and good ductility due to their uniformly refined grains less than 1~2μm by dynamic recrystallization and randomized texture by repetitive plastic working on the above scraps. Concerning to tensile properties of recycled AMX602 wrought alloy via RCP, Y.S, and elongation is 323MPa, and 14.8%, respectively. On the other hand, in using raw input chips, 217MPa Y.S and elongation of 19.2% are obtained. That is, RCP process is significantly useful to directly recycle Mg alloy wastes for up-grade materials.

11:30 AM

Quality Control Issues in Magnesium Scrap Recycling: *Bill Thompson*[1]; [1]US Magnesium, LLC

Magnesium alloys have been successfully recycled for decades and have won acceptance for use by die casters and most of the automotive industry. As the supply chain for magnesium and magnesium alloys continues to change, due to consolidation of producers, it is essential that quality control methods be closely examined with each new supplier added. An examination of the various process steps that are needed to assure quality in the final product will be discussed thus giving a basis for the auditing of new magnesium suppliers.

11:50 AM

Recycling of Heat Resistant Magnesium Alloys: *Norbert Hort*[1]; Karl Ulrich Kainer[1]; Daniel Fechner[1]; [1]GKSS Research Center

Magnesium components are increasingly used by the automotive industry to reduce the vehicles weight and thereby CO2 emissions. Apart from rather small components like steering wheels and seat frames, several bigger parts of the drive train have been introduced in the automotive industry. The rising number of magnesium components will result in a higher quantity of automotive scrap but so far post consumer scrap has not been used for magnesium alloy production. It is very complex to separate mixed post consumer scrap with regard to a chemical composition. Therefore it is useful to define secondary magnesium alloys made from blended post consumer scrap. To reconstruct the scenario of mixed post consumer scrap, a matrix of potential recycling alloys was prepared. The materials were investigated for their microstructure, mechanical properties, heat resistance and corrosion properties and the results will be shown.

12:10 PM

Recycling of Magnesium Alloys Aeronautical Parts for Obtaining Sacrificial Anodes: *Aurelian Buzaianu*[1]; Gabriela Popescu[2]; C. A. Popescu[2]; A. F. Olteanu[3]; I. Rusu[4]; P. Motoiu[5]; [1]S.C. Metav -Research and Development S.A; [2]University "POLITEHNICA", Bucharest; [3]Research and Development National Institute for Metals and Radioactive Resources, Bucharest; [4]"Gh. Asachi" Technical University; [5]R&D Institute for Nonferrous and Rare Metals

The paper introduces some technologic data on the recycling of aeronautical parts and scrap materials generated from disassembling magnesium alloys components, attempting to also solve the recycling of magnesium painted parts. The approach is meant to establish a superior quality method for recycling discarded parts or the excess of re-melting material in order to reduce the environmental impact and the costs. In nonconventional applications of magnesium alloys used as sacrificial anodes working in sea water, special alloying elements contribute to improving anodic processes. To make the alloy, Mg is fused and refined using salt mixture and specific elements. It was found that the use of recycled materials in anodes manufacture can reduce the Mg alloy cost by as much as up to 75% of the cost for virgin material, including the costs for the entire sequence of collection and transportation.

12:30 PM

Removal of Magnesium and Boron from Chloride Containing Spent Liquors: *M. Seref Sonmez*[1]; Murat Alkan[1]; Bora Derin[1]; Onuralp Yucel[1]; [1]Istanbul Technical University

Removal of magnesium and boron by selective precipitation from spent liquors obtained after the purification leaching of SHS product, B4C has been studied. Treatment of such liquor containing about 10000 ppm of magnesium and 400 ppm of boron is essential considering both an environmental issues

and resource sustainability. Controlled synthesis of particles in an aqueous medium was investigated. Reaction parameters studied were the effect of the initial concentration, duration, temperature, pH, and selected additives. Precipitates were analyzed and characterized in terms of chemical analysis, morphology, particle size, scanning electron microscopy, x-ray diffraction and thermo-gravimetric analysis.

General Recycling and Solid Waste Processing: Precious and Rare Metals I

Monday AM
October 13, 2008

Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Rajesh Mishra, A-1 Specialized Services and Supplies Inc

10:45 AM Keynote
Catalytic Oxidation of Cyanide by Zeolite and Ozone: *Francisco Carrillo-Pedroza*[1]; Ma. de Jesus Soria-Aguilar[1]; Marco Sanchez-Castillo[2]; [1]Universidad Autónoma de Coahuila; [2]Universidad Autónoma de San Luis Potosí

The cyanide contained in wastewaters of the metallurgical and mining industry is polluting specie for the environment. There are several industrial methods for the treatment of wastewaters containing cyanide; In general, its treatments can be divided in two groups: those that destroy the cyanide, oxidizing it and turning it to an innocuous species, and those that recover the cyanide. The objective of this work is to propose a process for the destruction of the cyanide by means of adsorption - oxidation using natural zeolite as adsorbent and ozone as oxidant. The results show that the oxidation process is catalyzed by the zeolite, were cyanide concentration decrease quickly, in a short time, with a very important impact in the ozone consume and, therefore, the cost of ozone generation.

11:10 AM
Co-Smelting of Auto-Catalysts in a DC Arc Furnace: Rodney Jones[1]; Isabel Reinecke[1]; *Steve McCullough*[1]; Peter Chennells[2]; [1]Mintek; [2]Independence Platinum

Auto-catalysts are a rich secondary source of platinum group metals (especially platinum, palladium, and rhodium), even though the available quantities of these materials are much lower than those of primary concentrates. One way to reduce the relatively high unit cost of smelting is to co-smelt auto-catalysts with other materials. This is currently practised on a small commercial scale at Mintek in Randburg, South Africa. A demonstration-scale (5.6 MVA) DC arc furnace has been run for a few years, on a toll-treatment basis, smelting a range of concentrates and tailings. Relatively small quantities of auto-catalysts (reject and spent) are added to the furnace from time to time. High recoveries of PGM are attained, with the PGMs being recovered in an iron-rich alloy. The FeO-MgO-SiO2 slag produced in this process contains negligibly small amounts of PGMs. Particular attention is paid to the sampling of the auto-catalysts for the purposes of metallurgical accounting.

11:30 AM
Extraction of Platinum Metals from Automobile Catalysts: *Vladimir Lobanov*[1]; Boris Radionov[1]; Andrew Evdokimov[1]; Vladimir Skorohodv[1]; [1]Ural State Technical University

The bulk of raw materials in metallurgy of secondary platinum metals are multilayered ceramic-metal systems (the spent catalysts of the chemical and petrochemical industry, automobile catalysts, etc.). The study of sorption leaching of platinum and palladium from the spent automobile catalysts are carried out. The average content of PGM is 0.5%. A few methods of raw materials sampling were compared: 1) direct hydrometallurgical leaching of platinum metals from the fine-grained catalyst and atomic absorption analysis of the solutions; 2) assay fusion with metal and sulphidic collector with the alloy analysis by direct spectrometry; 3) assay fusion with dissolution of a collector and atomic absorption analysis of solutions. Leaching allows detecting out less than 90% of palladium and 80% of platinum. Fusion with collector gives the best results at the chemical ending. Under optimum conditions the extraction of platinum metals by sorption is comparable with similar indicators of collector fusion.

11:50 AM
Hydrometallurgical Route to Recover Molybdenum, Nickel, Cobalt and Aluminium from Spent Hydrotreating Catalysts in Sulphuric Acid Medium: *Julio Afonso*[1]; [1]Institute of Chemistry - Federal University of Rio de Janeiro

This work describes a hydrometallurgical route for processing spent commercial CoMo and NiMo/Al2O3 catalysts for recovering the active phase and support components. They were initially pre-oxidized (500ºC, 5 h). Coke and other volatile species were eliminated. Preoxidized catalysts were dissolved in sulphuric acid (9 mol/L) at ~ 90ºC, and the remaining residue separated from the solution. Molybdenum was recovered at pH around 1.8 by solvent extraction using tertiary amines. Alamine 304 presented the best performance. After this step, cobalt (or nickel) was separated by adding ammonium oxalate at the above pH. Before aluminium recovery, by adding NaOH to the acidic solution, phosphorus (as diidrogenophosphate) was removed by a strong anion exchange column. The hydrometallurgical route presented in this work generates less final aqueous wastes, as it is not necessary to use alkaline medium during the metal recovery steps. Metals were isolated in very high yield (> 99 wt%).

12:10 PM
Processing of Grinding Waste of Rhenium-Containing Alloys to Manufacture Commercial-Grade Metals: *Andrey Tarasov*[1]; V. Paretsky[1]; A. Besser[1]; E. Gedgagov[1]; [1]Gintsvetmet Institute

Hydrometallurgical technology and equipment has been developed in the Gintsvetmet Institute (Moscow, Russia) for processing of rhenium-containing alloys waste to produce commercial-grade metal products with recovery of all valuable components. The technology is based on liberation of valuable constituents in HF with subsequent treatment with HNO3 to transfer rhenium and tantalum to a maximum degree into an equilibrium solution having pH = 1 to 1.5. Some experimental lots of ammonium rhenate and ammonium molybdate were produced at a pilot plant. The following main techno-economic performance values have been achieved when processing grinding residues (balance-based tests were conducted with a lot of SP-2 alloy waste) to produce ammonium rhenate, tantalum-niobium, tungsten-molybdenum and nickel-cobalt concentrates: 1)Rhenium recovery taking into account recycling of grinding waste into ammonium rhenate 92.3%; 2)Production cost of 1 kg of rhenium in commercial-grade ammonium perrhenate taking into account its recovery: 170-210 US Dollars; 1) Tantalum and niobium recovery into bulk concentrate: 75-77%; 2) Tungsten and molybdenum recovery into bulk concentrate: 88 91%; 3) Cobalt and nickel recovery into bulk concentrate: 88 89%.

Treatment of Liquid and Gaseous Effluents I

Monday AM
October 13, 2008

Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Carla Lupi, University of Roma La Sapienza

10:45 AM Keynote
Ferrihydrite and Aluminum-Modified Ferrihydrite Enhanced High-Density Sludge Treatment for Removing Dissolved Metals from Acid Rock Drainage: *Jerome Downey*[1]; Larry Twidwell[1]; [1]Montana Tech of the University of Montana

The high-density sludge (HDS) process is a commercially proven acid rock drainage (ARD) wastewater treatment process that relies on acid neutralization and metal precipitation. Previous studies have established that metal removal efficiencies in precipitation-based wastewater treatment applications can be improved through metal ion adsorption on ferrihydrite

and/or aluminum-modified ferrihydrite. This study was conducted specifically to determine whether the metal removal efficiencies at an existing industrial HDS wastewater treatment facility could be improved by promoting ferrihydrite and/or aluminum-modified ferrihydrite precipitation during the pH adjustment stages of the process. The metal tenors of the treated wastewater samples are compared with those obtained through baseline experiments, which were designed to simulate the conventional HDS operation. The subject metals were: aluminum, arsenic, cadmium, copper, iron, manganese, nickel, and zinc.

11:10 AM

Adsorption of Heavy Metals from Aqueous Solutions on Synthetic Zeolite: *Mohamed Barakat*[1]; [1]Central Metallurgical Research and Development Institute

Adsorption of heavy metal ions specifically, Cu(II), Zn(II), Mn(IV), and Cr(VI) from aqueous solution on synthetic 4A Zeolite was evaluated. The adsorption capacity of the metal ions were found to be strongly dependent on pH and initial metal ion concentration. At the optimium conditions the adsorption capacity decreased in the order Cu(II) > Zn(II) > Mn(IV) > Cr(VI) ions. Almost complete adsorption was achieved for both of Cu(II) and Zn(II) ions at pH > 6, while the adsorption capacity for both Mn(IV) and Cr(VI) was 96, and 55.3% at pH 11 and pH 3, respectively. The grain size of the 4A zeolite has a little effect on the adsorption capacity. The experimental data was compared with two adsorption isotherms, Langmuir and Freundlich isotheroms. The results showed a good agreement of the Langmuir plots with the experimental data.

11:30 AM

Cadmium (II) Adsorption onto Nanostructured Hybrid Material Derived from the Functionalization of Smectite Clay: *Angela Guimarães*[1]; Virgínia Ciminelli[2]; Wander Vasconcelos[2]; [1]Centro Federal de Educação Technológ-Ca de Minas Gerais; [2]Universidade Federal de Minas Gerais

The present work was aimed at synthesizing nanostructured hybrid materials derived from the functionalization of smectite clays with ligands containing thiol (-SH) groups for application in cadmium adsorption processes. An in nature Brazilian montmorillonite was investigated. The modification route was based on the grafting reaction between hydroxyl groups present on clay surface and the hydrolyzable alkoxy group of the (3-mercaptopropyl) trimethoxysilane in dry toluene under reflux. The thiol-functionalized montmorillonite samples showed average binding capacities 160% higher with respect to Cd(II) to those obtained with the ungrafted material. These results support a mechanism of adsorption involving primarily ion complexation by the thiol groups (specific) instead of cation exchange (unspecific). The proposed modification processes are suggested for the preparation of novel adsorbent materials with controlled selectivity and specificity and therefore with good potential for separation and pre-concentration purposes.

11:50 AM

Copper Elimination in Cyanidation Effluents: *Fabiola Nava-Alonso*[1]; Omero Alonso-González[1]; Alejandro Uribe-Salas[1]; Roberto Pérez-Garibay[1]; [1]Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional

Cyanidation is the most used method to recover gold and silver from their ores. In this process, other metals besides gold and silver may sometimes dissolve and interfere with the efficiency of extraction. Copper is one of these metals, reaching concentrations as high as 1000 mg/L in some cyanidation plants, making difficult the extraction and purification processes, and increasing the operating costs. This preliminary work studied the feasibility of using cationic quaternaries amines to eliminate copper from cyanidation solutions with high copper-cyanide concentration. The solid formed is removed from solution using conventional filtration techniques. Seven quaternaries amines were tested at different amine/copper ratio and pH value. Up to 90% of copper removal can be obtained at the pH value of the effluent (alkaline). With the remaining copper, it would be possible to recycle the solution to the cyanidation process.

12:10 PM

Electrochemical Purification of Cobalt Polluted Liquid Effluents: Carla Lupi[1]; *Pasquali Mauro*[1]; Alessandro Dell'Era[1]; [1]University of Roma La Sapienza

Industrial liquid effluents containing heavy metal ions arise in many metallurgical and chemical industries. The use of electrochemical methods can be considered for treatment of these wastes because they recover polluting substances in metallic forms and they do not produce sludge. In this work an electrochemical cell has been designed to treat very diluted cobalt solutions, i.e. those deriving from recycling processes of lithium-ion batteries. A RVC (reticulated vitreous carbon) cathode and a Pt-coated Ti net anode were used as electrodes. The potentiostatic electrolyses were performed on Co polluted solutions at 6.5 constant pH. The process yield is related to the Co solution concentration; starting with a solution containing 200 ppm of Co2+, the efficiency is initially ~35-40% and decreases to ~20% when 80% of the initial cobalt content has been electrowon. The current efficiency increases up to ~50% if the RVC electrode is coated by cobalt.

12:30 PM

Hydrothermal Mineralization Treatment of Hazardous Oxoanions in Wastewater for Resource Recovery: *Takeshi Itakura*[1]; Haruki Imaizumi[1]; Ryo Sasai[1]; Hideaki Itoh[1]; [1]Nagoya University

Emission of industrial wastewater containing harmful oxoanions is one of the serious problems on account of its toxicity and the environmental pollution, especially caused by boric, phosphinic, arsenic and antimonic species. In this study, we developed a novel treatment technique of such polluted-water by hydrothermal mineralization. The treatment is "Geo-mimetic" method for precipitating oxoanions in aqueous media as natural ore resources by using hydrothermal treatment with calcium salts mineralizer. The treatment made it possible not only to detoxify the polluted-water, but also to recover the calcium minerals such as Ca2B2O5•H2O, Ca5(AsO4)3(OH), etc. Concentration of each ion in treated-water was lower than that of effluent standard in Japan. Moreover, the residual concentration of each ion was independent of the initial concentration, but it depends only on the solubility of the formed mineral under hydrothermal condition. Therefore, the hydrothermal treatment could be recommended as one of the treatment techniques of polluted-water.

Automotive and Aerospace Recycling

Monday PM
October 13, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: John Pickens, Aleris International Inc

2:15 PM Keynote
Economic and Environmental Evaluation of Aerospace Aluminum End-of-Life Options Using a Chance-Constrained Optimization Model: *Gabrielle Gaustad*[1]; Elsa Olivetti[1]; Emily Chen[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology

As prices and demand of aluminum metal have increased over the past few years, secondary production has begun to outpace primary aluminum production. However, while recycling of packaging and automotive scrap have continued to increase, aerospace secondary materials remain a largely untapped resource. Shredded or co-mingled aerospace scrap has a high degree of compositional uncertainty due to the prevalence of high copper and high zinc alloy series. Although it is clear that upgrading strategies enable increased usage of aerospace scrap, it is not clear that they would be economic or efficient. Previous studies by the authors have shown that modeling techniques, specifically chance constrained optimization, provide the ability to evaluate upgrading options in terms of potential aerospace scrap utilization and production cost. Three specific cases are analyzed: a dismantled case, a sorted case, and a shredded or co-mingled case; sensitivity analysis of resulting compositional uncertainty is also presented.

2:40 PM
Mechanical Separation of Metallic Copper from Coated Copper Wire: *Seiji Yokoyama*[1]; Sakae Takeuchi[2]; [1]Toyohashi University of Technology; [2]Graduate School of Toyohashi University of Technology

It is very important to separate copper from the end of life vehicles and home electric appliances for recycling, because copper in scrap iron results in cracking of steel plate in a rolling. In this study, the attempts to separate the copper from a coated copper wire by rolling and by blender were made to examine the possibility of mechanical separation. In separation from a multi-conductor cable by rolling, the maximum ratio of recovered copper to that in a wire was 80% when the wire was hold at room temperature, while the maximum recovery ratio was about 95% when the temperature of the wire was below 0°C. The copper of single-conductor cables could be perfectly separated from a coated wire at one pass through the rolling machine. In separation from a multi conductor cable by a blender, the maximum recovery ratio was about 99%.

3:00 PM
Physical Separation of Crushed Product of Waste Nickel-Metal Hydride Batteries from Hybrid Vehicles: *Mayumi Ito*[1]; Masami Tsunekawa[1]; Kouki Kahiwaya[1]; Naohiro Sumiya[1]; Hisatoshi Furuya[1]; Naoki Hiroyoshi[1]; [1]Hokkaido University

The number of hybrid vehicles is increasing in Japan and this suggests an increase in waste nickel-metal hydride batteries. The cathode activating agent of batteries is made of nickel hydroxide and the anode activating agent is an alloy of nickel and rare earth elements. Conventional rotary kiln methods can not recover the rare earth elements and hydrometallurgical treatment of crushed product consumes large volumes of agent. The physical separation of the anode alloy from the cathode hydroxide would make it possible to reuse the alloy. The authors have reported that separation of anode and cathode components in the large size fractions is possible using a newly developed dry magnetic separation method. Wet magnetic separation was applied to the fine fraction and 90% anode purity was achieved. This paper reviews experimental results from previous publications and proposes an integrated treatment process for crushed nickel-metal hydride batteries.

3:20 PM
Preheating and Surface Cleaning of Steel Scrap by ASR: Guozhu Ye[1]; *Mikael Larsson*[1]; Sten Angstrom[2]; Eric Burstrom[1]; [1]MEFOS; [2]SSAB

Increased use of scrap in steelmaking including scrap use in BOF has a high economic and environmental potential in terms of increased productivity, energy saving and reduced emission of CO2. Preheating and surface cleaning of steel scrap is a concept developed by MEFOS in a four year research program funded by Foundation of Strategic Environmental Research (Sweden). The process concept consists of four major steps: 1) Combustion of ASR or other waste fuel and composing of the gas composition. 2) Scrap heating and cleaning in a shaft where the coated zinc is removed as ZnCl2 and scrap is heated to about 600C. 3) Dust separation for recovery of metal zinc. 4) Gas cleaning. This paper will describe the process concept and highlight the major results from preliminary trials around the scrap heating and cleaning shaft.

3:40 PM Break

Design for Recycling, Product-Service Systems, Dematerialization

Monday PM
October 13, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: John Pickens, Aleris International Inc

4:20 PM Keynote
Splash Technology: Applying the Design-for-Recyclability Concept to Spent Potlining Management: Courtney Young[1]; *Jerome Downey*[1]; [1]Montana Tech-University of Montana

Various technologies are available for treating spent potlining (SPL) from the aluminum industry and have been reviewed in the literature on several occasions. The technologies involve physical and chemical separations as well as thermal processes with primary objectives being total recycle, waste minimization, and/or delisting. In general, those geared for recycling involve separations and are therefore subject to recovery inefficiencies which can be attributed to a number of factors. However, it is believed that the inefficiencies can be eliminated or, at least greatly minimized, if the original pots were designed for recyclability. In this regard, the technologies are once again reviewed with specific reference given to SPLASH technology.

4:45 PM
Design and Engineering of the Plant for Man-Made Hydrocarbon-Containing Raw Materials Available in Countries of the Baltic Sea Region: Andrey Tarasov[1]; *Valery Paretsky*[1]; Erki Unn[1]; [1]Gintsvetmet Institute

The stability of the markets of energy resources and labor in countries of the Baltic Sea Region including Estonia is determined to a significant degree by the use of combustible shales as fuel and their distillation resulting in generation of up to 70% of non-recyclable waste. The objective of this business plan is to substantiate the investments for establishment of a new facility in Estonia for waste-less and environmentally safe processing of fossil minerals and man-made products generated in the shale industry, as well as other hazardous wastes. The proposed facility will use a basically new waste processing technology developed in Russia - i.e., processing in sparged molten slag This technology eliminates any release of harmful pollutants to the environment and a facility using this technology does not require, therefore, any sanitary protection zone.

5:05 PM
Design of Concepts for the Utilization of Residues and Wastes in Ajaokuta Steel Company: *David Esezobor*[1]; Sanmbo Balogun[1]; Samson Adeosun[1]; [1]University of Lagos

In a typical year, approximately 1.7 million tons of residues and wastes are expected from Ajaokuta integrated steel plant, Nigeria. They will be

generated mainly from sinter plant, blast furnace, BOF and during rolling and finishing, which include slag, dust, sludge and slurries from gas cleaning, waste water treatment, mill scales and other associated scraps. In this paper concepts for the utilization of residues and wastes in Ajaokuta Steel Plant where no reclamation routines have been provided for in the first and second phases of its project implementation is designed. The paper analyses the sources of the iron oxides wastes and the quantities expected from the main production facilities of the Ajaokuta Integrated Steel Plant are evaluated using plant's technical data, having 2 sintering machines of 312 m2 each and 2 blast furnaces of 2000 m3 each and 130-T BOF. Reclamation routine for Ajaokuta residues and wastes is designed

5:25 PM

Technology Based Design for Recycling and Eco-Design: *Antoinette van Schaik*[1]; Markus Reuter[2]; [1]MARAS - Material Recycling and Sustainability; [2]Ausmelt Limited

Eco-design and Design for Recycling (DfR) can only be conducted if the interconnectivity of material cycles is accounted for in recycling rate predictions and if the recyclate quality and its influence on metallurgical and thermal process efficiency can be linked back to design. Detailed product data on the material composition and connections in the product is required for the manufacturer for the benchmarking of product design in view of EPR, as well as to perform technology based DfR. Fundamental recycling models have been developed which capture these aspects. We discuss the application of our modelsin order to assess, evaluate and improve the recycling performance of products during the design phase. These tools can link computer aided design (CAD), conceptual design specifications of products, with the complex detail of the recycling system and recyclate quality, making recycling an integral part of the product system.

5:45 PM

Improvements in Ceramics for Boiler Protection in WTE Applications: *Champion Thibault*[1]; Christian His; Patrick Stephan; Stephan Mulch; [1]Saint-Gobain CREE

When fuel costs increase dramatically, waste-to-energy conversion technologies become a good alternative for energy production. The potential energy available in domestic wastes, in developed countries could be upwards of 4% of their total energy needs. Due to low energy recovery and low level of treated domestic wastes in many countries, the energy coming from waste is generally less than 0.5% of the country needs, but this varies widely across the globe. Domestic waste-to-energy processes with steam generation can convert heat to electricity for industry and housing and allow waste volume reduction, which has become of more concern, particularly in countries where landfills are increasingly restricted. Advances in combustion technology are resulting in increased energy recovery with better heat transfer in the boiler and also by increasing lining durability with more resistant materials and technologies. The knowledge of corrosion phenomena and material performance allows Saint-Gobain Group to develop and propose high performance refractory lining solutions.

General Recycling and Solid Waste Processing: Electronic Waste I

Monday PM — Room: Caesar 4
October 13, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Gabrielle Gaustad, Massachusetts Institute of Technology

2:15 PM Keynote

E-Waste Recycling in Latin America: Overview, Challenges and Potential: *Heinz Böni*[1]; Uca Silva[2]; Daniel Ott[1]; [1]EMPA; [2]Plataforma Regional de Residuos Electronicos de Computadores

Latin America is facing a rapid increase in Internet use. Penetration with electronic equipments has in some larger cities reached the level of OECD countries. There is an evident need to resolve the management of "end of life" computers and other electronic equipment. Several studies in Latin America confirmed the increasing quantities and importance of proper e-waste management. EMPA is since 2003 leading a global e-waste program oriented towards developing countries. This study gives an overview on the findings on a global scale, documents the status in the region, explains the challenges for establishing an e-waste management system and shows the social and economic potential and the chances of a regional approach.

2:40 PM

A Material Recovery Facility in Cape Town, South Africa, as a Replicable Concept for Sustainable e-Waste Management and Recycling in Developing Countries: *Mathias Schluep*[1]; Susanne Dittke[2]; Gerry Newson[3]; Cissé Kane[4]; Klaus Hieronymi[5]; [1]EMPA; [2]EnviroSense CC; [3]Recover-e Alliance; [4]Global Digital Solidarity Fund (DSF); [5]Hewlett-Packard Corporation

Hewlett Packard, the Digital Global Solidarity Fund and the Swiss Materials Science and Technology Institute Empa launched the project "e-Waste Management in Africa" in 2007. As part of this initiative a pilot project was started in Cape Town, South Africa, supporting the start-up of a professional material recovery facility (MRF) for the pre-processing of e-waste. The pilot's objective is to incorporate recent informal activities by transforming them into sustainable operations. In addition the MRF aims to act as a nucleus providing oppor-tunities for social upliftment, entrepreneurship and other value-adding activities, such as waste-to-art projects, educational initiatives and awareness creation. This study presents an analysis of the implementation of the MRF, presenting quantitative massflow data, financial numbers and social indicators as well as challenges and opportunities encountered in each phase. It will propose a blueprint concept for the sustainable instalment of MRFs into the specific environment of developing countries.

3:00 PM

Development of an Automatic WEEE Treatment Using Physical Separation Techniques to Limit Manual Sorting: Solène Touzé[1]; Maurice Save[1]; Christian Lucion[2]; Paul Hubaux[2]; *Nour-eddine Menad*[1]; [1]Bureau de Recherches Géologiques et Minières; [2]Centre Technologique International de la Terre et de la Pierre

Recently, in Europe the collection of WEEE is mandatory and is being organized. Current treatment processes involve a first step of manual dismantling. The main objective of this study was to develop an entirely automatic WEEE treatment procedure using physical separation techniques to limit manual sorting to the removal of hazardous components. The work consisted in testing different wet and dry physical separation methods on bulk WEEE: gravity separation (jig and pneumatic table), electric conductivity separation (eddy current and corona effect) and particle shape separation (Lavodune classifier and helicoidal vibrating conveyors). The test results enabled to determine a global treatment flow sheet: shredding, electromagnetic separation, eddy current separation, screening (2mm), sink&float separation (d=1) and jigging. There are possible recovery chains for all of the end products except for the fine fraction. These tests show that batches of WEEE can be treated automatically if the non ferrous wires problem is solved.

3:20 PM

E-Waste Generation in Chile: Analysis of the Generation of Computer Waste Using Material Flow Analysis: *Bernhard Steubing*[1]; Christian Ludwig[2]; Heinz Böni[1]; [1]EMPA; [2]Paul Scherrer Institute

Chile will soon have to find solutions for dealing with rapidly growing quantities of Waste Electrical and Electronic Equipment (WEEE) due to its strong economy and fast increase of internet and communications technology usage. To support this process, the state of the Chilean recycling infrastructure as well as government, industry and consumer efforts to deal with e-waste were analyzed. Current e-waste quantities were assessed and future flows were predicted using a material flow analysis model. In this model computer hardware was used as tracer equipment for WEEE. Best available numbers indicate that today's formal recycling infrastructure receives less than 3% of the annual quantities of computer waste. This study represents the most comprehensive analysis regarding e-waste in Chile, identifying relevant streams of e-waste and providing a basis for authorities and producers of

electronic goods in order to take the necessary actions to establish an adequate recycling system.

3:40 PM

Mechanical and Pyrometallurgical Recycling of Electronic Wastes: *Lifeng Zhang*[1]; Xiangjun Zuo[1]; Jaan Kers[2]; Dmitri Goljandin[2]; Priidu Peetsalu[2]; [1]Missouri University of Science and Technology; [2]Tallinn University of Technology

In this paper, the mechanical milling of the electronic wastes were carried out. The metal parts and plastic parts were roughly separated. The final plastic powder size could be as small as ~100 μm. Then the pyrometallurgical recycling Printed Circuit Boards (PCB) was executed. The mechanisms of thermal degradation and combustion are investigated using TG/DTA and MS machines. The effects of top temperature, holding time, gas flow rate, heating rate were investigated. Some chemical powders, such as Na2CO3 and CaCO3 are used to diminish emission of the toxic gas such as Br2 and others. An industrial scale thermal recycling electronic wastes were discussed.

4:00 PM Break

Economic Evaluation of Waste Treatment Strategies

Monday PM
October 13, 2008

Room: Caesar 4
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Gabrielle Gaustad, Massachusetts Institute of Technology

4:20 PM Keynote

A Social Enterprise Approach to Servicing the Zero Waste Community: *Eric Lombardi*[1]; [1]Eco-Cycle Inc.

The social discussion has evolved "beyond recycling" and into two new areas: (1) the idea of "Zero Waste Community Planning" (ZWCP), and (2) the question of who will service a Zero Waste Community? The first issue addresses the ever-evolving collection challenges (including biodegradable materials recovery, hard-to-recycle materials recovery, and product re-use), while also addressing the emerging "upstream" waste reduction topics (such as extended producer responsibility, regulatory "new rules" and Zero Waste purchasing practices.) The issue of who in the marketplace will service this new policy direction explores why recycling growth in America has stalled out and how a "social enterprise"(SE) approach can reinvigorate the public support for increased community waste reduction and resource conservation. SE is a growing global trend by non-profit organizations to support themselves through earned-income activities (rather than charity). The author runs the largest recycling SE in America, Eco-Cycle Inc, in Boulder, CO (www.ecocycle.org).

4:45 PM

A Contribution to the Strategic Analysis of Alternatives for Waste Management in Valle de Aburrá Area, Medellín-Colombia: *Enrique Posada*[1]; [1]INDISA S.A.

The Valle de Aburrá area, corresponds to the city of Medellín and neighboring municipalities, with more than 3 million people. The area generates a sizable amount of solid waste, which has been taken to landfills for the last 20 years. This paper proposes a model for public policy making which considers the cost and benefit of different alternatives to handle the wastes in the coming 20 years. Combinations of several alternatives: Recycling, waste reduction, waste separation, incineration, land filling with lixiviate treating and gas energy recovery, and organic waste composting are considered and modeled and the results presented as a contribution for a more rational approach to policy making than the one currently being employed.

5:05 PM

Economic and Environmental Evaluation of Various Aluminum Scrap Upgrading Options Using Chance Constrained Optimization Modeling: *Gabrielle Gaustad*[1]; Elsa Olivetti[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology

As scrap usage increases, it is often necessary to "dilute" the melt with primary aluminum to ensure the finished product meets compositional specifications. Secondary raw materials, particularly post-consumer scraps, often include high levels of unwanted or "tramp" elements, such as iron and silicon in the case of aluminum. Recent literature on this issue cites several causes including inherent contamination during processing as well as ineffective segmentation at end-of-life. To address this accumulation problem, "upgrading" solutions have been developed including: dismantling of end-of-life products, spectrographic or magnetic sorting of shredded scrap, and "filtration" technologies that remove tramp elements in the melt. Although it is clear that upgrading strategies enable increased usage of scrap, it is not clear that they would be economic or efficient. This work presents a set of analytical methods, based on chance constrained optimization, to quantify the potential environmental and economic value of several scrap upgrading technologies.

5:25 PM

Innovation Technologies of Solid Minerals Processing in the Arctic Zone with Waste Minimization: *Tsukerman Vyacheslav*[1]; Ludmila Ivanova[1]; [1]Institute for Economic Studies

Dynamics of general economic growth is to a considerable extent determined by results of research, technical and innovation policies in the Arctic zone of Russia. Evaluating contribution of innovation-technological development of the economy in growth of the country's GDP, scholars assign 70-80% to this factor's share. Mineral formations, accumulated during industrial epoch, affect significantly economic and ecological situation in the Arctic region. On the one hand, production wastes destroy the region's environment. On the other hand, technogenic mineral formations contain a lot of valuable scarce components. The amount of solid wastes increases annually. Transition to innovation economy provides re-comprehension of mining enterprises in society. Actions should be directed to radical renovation of production technologies. It will ensure rapid growth of competitiveness, increased demand and stronger position at the international market. Development of innovation technologies can be provided at the expense of active state and private innovation activities.

General Recycling and Solid Waste Processing: Non-Ferrous Metals I

Monday PM
October 13, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Mark Schlesinger, Missouri University of Science and Technology

2:15 PM Keynote

Aluminum Recycling – An Integrated, Industry – Wide Approach: *Subodh Das*[1]; John Kaufman[2]; John Green[3]; [1]Phinix, LLC; [2]Secat Inc; [3]JASG Consulting

The aluminum industry is a leading proponent of global sustainability and strongly advocates the use of recycled metal. With the gradual demise of the U.S. primary smelting industry, recycled metal now exceeds primary production levels. As the primary industry continues to move offshore and invest in the "energy islands" in geographic areas where the energy supply is more readily available and obtainable at lower cost, the importance of secondary material in the U.S. will become increasingly significant. The purpose of this paper is to take an integrated, industry-wide approach to look at the recovery of material from shredded automobiles, from aging aircraft stored in the western deserts, from demolished or deconstructed buildings as

well as from the traditional containers and cans. Attempts will be made to assess how the different alloys used in these separate markets can be recycled in the most energy, cost, and environmental efficient manner.

2:40 PM

Characterization and Possible Treatment Routes of the Solid Waste Generated by the Caron Process of Nickel Production: *Marcelo Mourao*[1]; Cyro Takano[1]; Neusa Alonso-Falleiros[1]; Carlos Giraldo[1]; [1]University of Sao Paulo

The Carom process of nickel extraction from lateritic ores produces a fair amount of an inert residue, the so-called "black sludge", that is disposed in a dam according to the required environmental regulations. On the other hand, it represents an opportunity to resource recovery. This work presents the characterization of the residue, discusses some possible ways to recover the valuables, and presents experimental results of pyrometallurgical runs aimed at recover nickel as an iron-nickel alloy. It has been shown that the residue contains large amounts of silicon, iron, aluminum and magnesium, in the form of oxides and silicates, and small quantities of nickel, cooper and cobalt, besides several other elements. It has also been shown that gravimetric or magnetic concentration methods do not present promising results. On the other hand, it is possible to obtain iron-nickel alloys by high-temperature carbothermic reduction of the "black sludge".

3:00 PM

Effects of Al_2O_3 on Mineralogy of the Fayalite Slag: *Sina Mostaghel*[1]; Caisa Samuelsson[1]; [1]Luleå University of Technology

Rönnskär smelter of Boliden Mineral AB, Sweden, is well known for recycling of base and precious metals. Slag from the electrical furnace is processed at the fuming plant to produce zinc clinker. The granulated slag, later on, is a by-product used as e.g. construction material. In this paper, influences of Al_2O_3 on mineralogy of the slag, which can affect its chemical and physical properties, are investigated. Different mixtures of Al_2O_3/fumed slag were prepared. Re-melting was carried out in a Thermo-Gravimetry (TG) furnace with an inert atmosphere. Scanning electron microscopy (SEM) and X-ray diffractometer (XRD) were the applied instruments for the analyses. Investigations depict that addition of alumina to slag, results in an increase in the number of spinels and a transformation from iron rich to aluminum rich spinels. Anorthite ($CaAl_2Si_2O_8$) will also be formed in the fayalite phase.

3:20 PM

Hydrometallurical Extraction of Zinc and Lead from Çinkur Leach Residue: *Yavuz Topkaya*[1]; Aydin Rüsen[1]; [1]Middle East Technical University

In this study, zinc and lead recovery from zinc plant leach residue obtained from Çinkur using hydrometallurgical methods have been investigated at laboratory scale. Considering more than one million tons of leach residue (LR) containing 12.43%Zn and 15.51%Pb in the stockyard which is environmentally hazardous, it is essential to process it. As a first step, Çinkur LR was releached by using hot sulphuric acid for zinc recovery. About 72% Zn was recovered by using 150 g/l H2SO4 at 95°C in 2 hours with a pulp density of 200 g/l. Secondly, for lead recovery brine leaching tests were performed on the secondary Çinkur LR obtained after acid leaching process. In brine leaching while lead recoveries up to 98% could be attained at a low pulp density, the maximum recovery obtained was 84.9% at a high pulp density (200 g/l) with 300 g/l NaCl concentration in 10 minutes at 95°C.

3:40 PM

Innovative and High Economic Burner Systems for Recycling Furnaces: *Michael Potesser*[1]; Burkhardt Holleis[2]; Adrianus Hengelmolen[3]; Helmut Antrekowitsch[1]; Davor Spoljaric[4]; [1]University of Leoben; [2]Messer Austria GmbH; [3]Hengelmolen Furnace Systems; [4]LLC Elme Messer Gaas

During the past only an optimization of metallurgical furnaces were done without attention on the burners. Nevertheless, furnaces without burners are impossible to use in the primary and secondary nonferrous metallurgy in an economic way. Since the energy cost is increasing and the environmental protection is becoming a global issue, the burners are in the focus of several investigations and optimizations. One possible way is the combustion by oxygen. By using oxygen, the flame temperature increases and therefore, fuel accordingly money could be saved by having a low amount of harmful substances like NOx in the off gas. This paper describes a new burner system which combusts fuel with oxygen or air by diluted combustion, hence low pollutants in the off gas. Furthermore the effectiveness of the burner characterized by off gas analyses and simulation in the new development chamber, but also practical tests at an aluminium smelter are described.

4:00 PM Break

General Recycling and Solid Waste Processing: Non-Ferrous Metals II

Monday PM
October 13, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Mark Schlesinger, Missouri University of Science and Technology

4:20 PM Keynote

Physical Processing Efficiency of Saline vs. Alkaline Spent Batteries: Marta Cabral[1]; *Carlos Nogueira*[2]; F. Margido[1]; [1]CVRM - Centro de Geo-Sistemas, Instituto Superior Técnico, Technical University of Lisbon; [2]Instituto Nacional de Engenharia, Technologia e Inovação, DMTP

Physical processing of spent batteries which includes shredding and sieving operation is the first step for chemical treatment by hydrometallurgy. A laboratory study was carried out to evaluate physical processing efficiency, by analysing the resulting particle size, of alkaline and saline mignon-type Zn-MnO2 batteries. After shredding with a tip shredder, results obtained showed that alkaline batteries were more efficiently size reduced than saline batteries. Difference in particle size distribution was larger for granulometric fraction -20+11.2mm and also higher for saline batteries. Average diameters (d50) for saline and alkaline batteries were respectively 9.1 and 6.2 mm. Chemical composition carried out on several granulometric fractions allowed to identify metals distribution through size categories. This analysis showed that zinc concentration with the grain size was almost constant, while manganese decreased when particle size increased. More than 95% of iron scarp from the battery cases had a particle size higher than 5.6 mm.

4:45 PM

Light Metal Alloy Particle Sorting: Technology Enabling Expanded Use of Source-Segregated Scrap in Automotive, Marine and Aerospace Markets: *Adam Gesing*[1]; Hartmut Harbeck[2]; Bjørn Hansen[3]; [1]Gesing Consultants Inc.; [2]CommoDaS GmbH; [3]Tomra Systems ASA

Composition- and property-critical alloys (such as Al-Li and Mg-RE alloys) for aerospace, defense, marine and automotive markets tend to have tight composition limits and to use exotic alloying elements. These are composition incompatible with most of the common alloys in the present material-recycling loop. Aluminum producers and fabricators of semi-products attempt to maximize the re-use of prompt scrap in their own plants in the original alloys. There is a reluctance to accept nominally alloy-segregated manufacturing scrap for these composition- and property-critical applications. The result is that the expensive alloying elements are either lost by dilution in non-critical foundry alloys, or are refined out and lost by chlorination or selective precipitation. We show how an automated particle sorter equipped with an elemental composition analysis sensor could be used to address this problem efficiently and economically, enabling recycling of Al and Mg alloy-segregated scrap within the key alloy and product families.

5:05 PM

Metals Recovery from Spent Zn-MnO_2 Batteries by Hydrometallurgy: R. Guerra[1]; F. Margarido[1]; *Carlos Nogueira*[2]; F. Pedrosa[2]; [1]CVRM - Centro de Geo-Sistemas, Instituto Superior Técnico, Technical University of Lisbon; [2]Instituto Nacional de Engenharia, Tecnologia e Inovação

A hydrometallurgical process for recycling spent Zn-MnO_2 batteries was developed, involving leaching with sulphuric acid, purification by precipitation and metals separation for further recovery. Leaching of zinc oxide was

easily attained while for manganese oxide was rather difficult depending on temperature and acid concentration. At 90°C and with the solid/liquid ratio of 20 L/kg, more than 95% of zinc is recovered in 30 minutes with 0.5M H_2SO_4. To attain similar recovery for manganese, higher levels of acid concentration and time are needed (e.g 0.7M and 2 hours). After leaching a purification step is necessary to remove iron co-dissolved through goethite precipitation. Separation of zinc from manganese by solvent extraction with 1M DEHPA follows in the process route. The countercurrent multistage separation diagram developed allows the production of a zinc electrolyte with 120 g/L Zn and 0.005 g/L Mn, and a raffinate with 16 g/L Mn and 0.013 g/L Zn.

5:25 PM

Minor Element Control by Flue Dust Treatment in Copper Smelting: *Roberto Parra*[1]; Igor Wilkomirsky[1]; F. Parada[1]; R. Parada[2]; [1]University De Concepción; [2]Fundición Chagres, Anglo American Chile

A novel process for minor elements control in copper pyrometallurgical production is proposed. Its application can solves operational problems related to volatile elements that determine pollutants gas emissions and the final quality of anodes. The process considers a calcination of mixtures of the dust with sulfidizing agents such as dirty copper concentrate or elemental sulfur at temperature under 800ºC. The product are a clean calcine that recovers all the Cu content on the dust and a gas stream that collect the minor elements as sulfides species. The calcine can be returned to the smelter avoiding the As increasing in the circuit and so on, the capacity for the treatment of dirty concentrates for the smelter can be higher. The possibility to apply vacuum in the calcinations step can decrease the operation temperature. The solid condensed from the gas stream has a high As content and an in situ stabilization of As with molecular hematite is analyzed from fundamentals calculations and laboratory experiments. All the experimental results have shown a good agreement with the theory and allow predicting almost fully elimination of As, Sb and Bi contained in flue dust.

5:45 PM

Options for Recycling the Fine Ni-Containing Waste in Ukraine: *Vladyslav Sokolov*[1]; Boris Bondarenko[2]; Vladyslav Yakubovsky[2]; Valentin Noskov[3]; [1]Physico-Technological Institute of Metals NANU; [2]Gas Institute; [3]Iron and Steel Institute

Each of Ukrainian producers of ferronickel, stainless steel and artificial diamonds has the same basic problem with recycling there fine Ni-containing waste. The conditions for generation of the wastes along with there properties were investigated in details. The reasons of complexity for the in-site or out-site waste processing were found out. The new approaches have been proposed. They are based on application of some pyrometallurgical processes that are used in Ukraine. The proper equipment is also available. It has been shown that the dust from laterite calcining process of ferronickel production should be efficiently recycled by sintering. The stainless steel dust should be smelted after briquetting as a charge addition to discarded batteries in the elaborated furnace. The sludge after industrial diamonds production should be pelletized and processed by liquid cast iron with application of induction magneto-dynamic forces in the specific unit.

General Recycling and Solid Waste Processing: Precious and Rare Metals II

Monday PM
October 13, 2008

Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Vladimir Skorohodv, Ural State Technical University

2:15 PM Keynote

Recycling of PGM from Used Automobile Cataytic Converters: *Rajesh Mishra*[1]; [1]A-1 Specialized Services and Supplies Inc.

About two million ounces of platinum, palladium and rhodium (PGM)are currently recycled per year from used automobile catalytic converters. The number is supposed to increase to six million troy ounces in next ten years. The extraction and recovery of platinum, palladium and rhodium can be achieved either by pyrometallurgical, hydrometallurgical or gas phase volatilization processes.This paper is a comparative study of these processes with special emphasis on their technical, economic and environmental aspects.

2:40 PM

Processing of Spent Button Cells: *Julio Afonso*[1]; [1]Institute of Chemistry - Federal University of Rio de Janeiro

This work presents hydrometallurgical routes for recovering valuable elements from spent Li/MnO2, Zn-air and Ag-Zn button cells. These routes are based on leaching of internal components with sulphuric acid (Li/MnO2 and Zn-air) or nitric acid (Ag-Zn), at 90°C for 2 h. A slow evaporation of the leachate crystallized manganese as MnSO4.H2O; lithium was partially recovered as LiF. The residual acid solution can be used to treat new spent Li/MnO2 cells. Mercury present in Zn-air and Ag-Zn samples was precipitated as HgS. Silver was recovered as AgCl before mercury precipitation. Zinc was kept soluble by adding NaOH(aq.), whereas iron precipitated as hydroxide. Zinc was isolated as hydroxide after adding sulphuric acid(pH ~8). The amount of iron in the leachate varied according to the intensity of the corrosion of the external stell case. Final wastes occur as colorless and neutral sodium sulfate/nitrate solutions.

3:00 PM

Sorption Concentration of Platinum Group Metals from Nitrate Solutions: Svetlana Babaeva[1]; Olga Makovskaya[1]; Andrew Shabalin[1]; *Vladimir Skorohodv*[1]; [1]Ural State Technical University

At processing of some kinds of wastes (electronic scrap, secondary materials, spent nuclear fuel) in nitric acid solutions, and also in technology of silver refining, the significant amounts of palladium and platinum passes into a solution. The ion-exchange concentration of palladium and platinum in nitric acid solutions (5-500/dm^3) are investigated. More than 30 various classes of ionites are tested. The most chemically resistance resins at the given conditions are identified. It is shown, that the maximum sorptive capacity to studied metals at high acidity the complexing, synthetic and inorganic sorbents possess. To definition of platinum metals sorption optimum conditions the kinetics is studied, isotherms of a sorption at various parameters from nitrate solutions are obtained. The conditions of the platinum and a palladium desorption from the pregnant sorbents and its regeneration with the subsequent reuse of materials were defined.

3:20 PM

Use of the Modified Sorbents for Extraction of Precious Metals: *Vladimir Lobanov*[1]; Boris Radionov[1]; Olga Makovskaya[1]; Vladimir Skorohodv[1]; [1]Ural State Technical University

The synthetic sorbents and the activated carbons which are used for the metals extraction from weak process liquors are rather expensive. It is propose to use mineral and synthetic high-porous substances which sharply increased sorption properties by special processing. For achievement the desirable properties sorbents are impregnated by specially prepared solutions. Such solutions should contain the substances or its anionic forms which are fixed strong enough in a supporter pores and are capable to form the insoluble compounds with extracting metals. Selectivity is provided by chemism of the reagent interactions with extracting metal. Due to the high concentration of a reacting ion in a sorbent phase the capacity and rate of sorption increases. Formed insoluble compound remains in the sorbent phase and necessity of its filtration disappears.For synthesis the sulfhydryl compounds which chemical properties allow to increase degree of extraction and capacity of the activated carbon were used.

3:40 PM Break

Life Cycle Assessment, Modeling and Analysis of Recycling Behavior

Monday PM
October 13, 2008
Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Anna Allen, Massachusetts Institute of Technology

4:20 PM Keynote
Methods for Managing Uncertainty in Material Selection Decisions: Robustness of Early Stage Life Cycle Assessment: *Anna Allen*[1]; Annika Larsson[1]; Subodh Das[2]; Jeremy Gregory[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology; [2]Phinix, LLC

Utilizing alternative materials is an important tactic to improve the environmental performance of products. Currently a growing array of materials candidates confronts today's product designer. While life-cycle assessment (LCA) methods provide quantitative input into this selection decision, their implementations are evolving and disparate. The goal of this paper is to explore several major analytical variations of LCA implementations and the implications of these variants across a range of application contexts. Specifically, this paper examines analytical variations in valuation method and treatment of recycling by exploring allocation methods that affect product end-of-life. Case studies across a range of materials are presented, including materials that exhibit a spectrum in variation of environmental performance and material degradation between primary and secondary applications. Preliminary results indicate that the choice of analytical method can have real impacts on individual metrics and there are sets of analytical variation over which strategic results are strongly affected.

4:45 PM
Mineral Liberation Analyzer: Current Secondary Material Projects at the Center for Advanced Mineral and Metallurgical Processing: *Paul Miranda*[1]; Corby Anderson[1]; [1]University of Montana, Montana Tech

The Center for Advanced Mineral and Metallurgical Processing (CAMP) has recently obtained a Mineral Liberation Analyzer (MLA) and has currently evaluated over 40 global projects using this new technology. CAMP has utilized the technology for several recycling projects with excellent results. The MLA is able to both analyze and quantify minerals, slags, and other phases. For this presentation, current CAMP projects have been evaluated and data collected using the MLA. These projects include a Platinum Group Metal (PGMs) refiner evaluation using recycled autocatalysts located in Montana. A potential gold and PGM tailings pile was considered using the technology. Next, a potential slag pile which may contain gold and silver bearing phases was evaluated. A slag recycling application for mine water treatment was also evaluated Lastly, a potential recycled tailings pile which contained silver was analyzed. For all projects, MLA application results will be presented and discussed.

Recycling in Building and Construction Industries I

Monday PM
October 13, 2008
Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Francisca Puertas, Eduardo Torroja Institute (CSIC)

2:15 PM Keynote
Ceramic Tile Wastes as Alternative Raw Materials for the Production of Portland Cement Clinker: *Francisca Puertas*[1]; Irene García-Díaz[1]; Antonio Barba[2]; Mª Fernanda Gazulla[2]; Marta Palacios[1]; Mª Pilar Gómez[2]; Mª Sagrario Martínez-Ramírez[1]; [1]Eduardo Torroja Institute (CSIC); [2]Institute of Ceramic Technology

The cement industry has for some time been seeking procedures that would effectively reduce the high energy and environmental costs of cement manufacture. One such procedure is the use of alternative materials as partial replacements for fuel, raw materials or even clinker. The present study explores the reactivity and burnability of cement raw mixes containing fired red or white ceramic tile wastes or combinations of the two as alternative raw materials. The results showed that the new raw mixes containing these wastes are technically viable. The reactivity and burnability of the new raw mixes have been evaluated; confirming very good results with the particle size of wastes was less than 90 µm. The chemical and mineralogical compositions of the new clinkers were comparable to clinker manufactured with conventional raw materials.

2:40 PM
Characterization and Incorporation of Paper Sludge Waste into Clay Bricks: Regina Pinheiro[1]; Carlos Mauricio Fontes Vieira[1]; *Sergio Neves Monteiro*[1]; Rubén Sanchez[1]; Djalma Souza[1]; [1]Universidade Estadual do Norte Fluminense

This work has for objective the characterize a waste generated, in the sludge form, during the paper making and evaluate the effect of the incorporation of waste up to 10 wt.% on the properties and microstructure of a clayey body used for fabrication bricks. For the characterization of the waste the following techniques were used: X-ray diffraction, X-ray fluorescence, differential thermal analysis and termogravimetric analysis, and scanning electron microscopy (SEM). Specimens were prepared by uniaxial pressing at 20 MPa before firing at 750°C. The evaluated physical and mechanical properties were: linear shrinkage, water absorption and flexural strength. The microstructure was evaluated by SEM. In agreement with the characteristics of the waste, its recycling into red ceramic can contribute to decrease the consumption of fuel during the firing stage. However, the waste changes the physical and mechanical properties, generating a deleterious effect on the water absorption and flexural rupture strength.

3:00 PM
Development of Recycled Aggregate Producing Process Waste Concrete Using a Autogenous Mill and Density Separation: *Kwan Ho Kim*[1]; DuckJae Lee[1]; HeeChan Cho[1]; JiWhan Ahn[2]; [1]Seoul National University; [2]Korea Institute of Geoscience and Mineral Resources

In order to produce a high quality recycled aggregate from waste concrete, a better process was developed comprising of heat pretreatment, autogenous milling, and density separation. Test results indicated that produced recycled coarse aggregate after 30 minute milling time using autogenous mill has a density of 2.5g/cm^3 and a water absorption ratio 3.0%, which meet the specification of the first class of KS F 2573. Using these results, continuous process was developed and the produced recycled coarse aggregate also met the specification of the first class of KS F 2573. From the lab scale test results, pilot scale autogenous mill was constructed and tests were further conducted. The first class recycled coarse aggregate could be produced about 25% from heat treated waste concrete sample. Moreover, additional process is being tested to recover fine aggregates using density separation and hindered settling separation.

3:20 PM
Recycling of Ornamental Rock Waste into Clayey Ceramics: *Carlos Maurício Vieira*[1]; Sergio Neves Monteiro[1]; [1]State University of the Northern Fluminense

This work has as its objective to evaluate the effect of ornamental rock, gnaisse, powder waste incorporation in an industrial clayey body used for roofing tiles fabrication. Formulations with 0, 10, 20 and 30 wt.% of waste were prepared by substitution of sand in the industrial clayey body. the Plasticity of the formulations was determined by Atterberg limits. Specimens were fabricated by 18 MPa uniaxial pressure and then fired from 850 to 1100°C. The specimens were tested to determine the water absorption, linear shrinkage and three points bending flexural strength. The results indicated that the waste improves the extrusion of the clayey body by decreasing its plasticity. The use of the waste was beneficial to the water absorption and mechanical strength of the fired clayey ceramic at temperatures above 1000°C.

3:40 PM Break

Recycling in Building and Construction Industries II

Monday PM
October 13, 2008

Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Francisca Puertas, Eduardo Torroja Institute (CSIC)

4:20 PM Keynote
The Recycling of Construction and Demolition Waste: The Quality Standards for the Reuse in Construction Field: Alessandra Bonoli[1]; *Marianna Garfi*[1]; [1]Università di Bologna

Construction and demolition waste (CDW) is no dangerous, uncontaminated material resulting from construction, renovation, repair, and demolition of houses, large building structures, roads, bridges, piers, and dams. Before recycling the CDW were discharged in landfills. Today it is possible to recycle these materials, to reduce environmental impacts, and to reuse them in construction sector. To evaluate the possibility to reuse this material it is important to lead laboratory tests to assess the proprieties and quality characteristics. European, Italian and British ad hoc Committees had elaborate specific Standards, to evaluate Geometrical, Physical, and Chemical requirements of recycled materials. A research was carried on to define the guidelines for laboratory tests, their suggested values and quality standards.

4:45 PM
Rejected Sands from Smelting Metallurgical Process Used in Structural Ceramics: *Francisco Valenzuela-Díaz*[1]; Cassio de Carvalho[1]; Shirley Cosin[1]; Guillermo Martín-Cortés[1]; [1]Polytechnic School of University of São Paullo

Rejected sands from smelting metallurgical process because contain lead and others heavy metals are a problem to dispose as waste in all the countries. A procedure that is being proposed for it is to incorporate it on common clay bodies in the fabrication of structural ceramic products as bricks, blocks and roof tiles. The main goal of this paper is to present the results obtained with mixtures of sands from smelting metallurgical process with common clay from Jundiaí, São Paulo, Brazil. Preliminary incorporation tests (1,0% - 30,0% in weight) were made with hand formed spherical samples. With the higher compression strength of the spheres after drying and firing (950ºC) experiments on bricks production were made for quality technological test. Seven hundred hallow blocks containing 1,0% waste were produced and presented ceramic properties similar to those without sand incorporation. For health problems prevention leaching and emission gasses quality tests are planned.

5:05 PM
Upgrade of Mixed C&DW Recycled Aggregates Quality by Automatic Sorting: Sergio Angulo[1]; *Anette Mueller*[2]; [1]Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo; [2]Bauhaus-Universität Weimar

Gypsum, red brick and cement paste adhered on the natural rocks can decisively reduce the quality of recycled aggregates from mixed construction and demolition (C&D) waste for the use in concrete. The automatic sorting can be used to separate such materials by optical (to separate gypsum and red brick) and dual XRT sensors (to separate enriched cement particles), and, then, to upgrade the aggregate quality. So, this paper investigated the separability efficiency of such materials by automatic sorting. Three gypsum composite (with paper, wood or natural rock) components, a mixed C&D aggregate and pure aggregates (concrete, mortar and red brick) were characterized, mixed to form nine different samples, and, then, submitted to the sorting essay. To sum up the separability of gypsum and red brick can be successfully achieved by until two processing steps. The other results will be discussed further.

5:25 PM
Usability of the Turkish Coal Bottom Ash and Natural Zeolite in Concrete Applications: *Haldun Kurama*[1]; Cenk Karakurt[1]; Ilker Topçu[1]; [1]Osmangazi University

The usage of binders or pozzolanic materials in the production of concrete is not new. However, in recent years, the usage of the pozzolanic siliceous material such as natural zeolite and coal combustion ash (BA) has received re-attention due to the generated considerable interest in the economical use of both naturally occurring raw materials, recycling of the waste material and saved energy. In this study, the potential and utilization opportunities of natural zeolites and BA in concrete applications were reviewed. Case studies, conducted to determine the possible usage of the natural zeolite and BA in concrete production, i.e. light weigh concrete (LWC) were also presented. The physical properties such as compressive and flexural strengths, thermal conductivities of cured concretes were examined to find out the competitive material usage on the final product properties. Chemical and microstructure properties of the raw and final products were determined by XRF and SEM analysis.

5:45 PM
Valorization of Mineral Wastes for Ceramic Industries: Janaína Junkes[1]; Fabiano Pereira[2]; Viviana Della[1]; Gabriel Cunto[1]; *Dachamir Hotza*[1]; [1]Universidade Federal de Santa Catarina; [2]Senai/SC

The present work investigated the valorization of wastes as alternative raw materials for ceramic industries. Different industrial wastes based on the SiO2-Al2O3-K2O system and classified as non-hazardous were selected: sludge from varvite cutting process, sludge from gnaisse breaks processes and sand from fluorite extraction process. All as-received residues were characterized by X-ray fluorescence, differential thermal analysis, thermogravimetry, X-ray diffraction and particles size distribution. The applicability of these materials in ceramic formulations was then evaluated. The formulated mixtures were subjected to forming by pressing and extrusion followed by thermal treatment. After optimization of the processing conditions, the properties of the samples sintered at different temperatures was also evaluated. The waste materials studied proved to be alternative raw materials to natural mineral resources for the ceramic industry.

Waste Conversion and Reutilization I

Monday PM
October 13, 2008

Room: Caesar 6
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Neale Neelameggham, US Magnesium LLC

2:15 PM Keynote
Characterization of MA-MOX Powders and Pellets: *Angelique Neuman*[1]; Charles Davis[1]; Troy Nothwang[1]; Fredrick Hampel[1]; Stewart Voit[1]; Michael Lopez[1]; Anthony Martinez[1]; [1]Los Alamos National Laboratory

One of the thrust areas for the Global Nuclear Energy Partnership (GNEP) program is the development of actinide bearing fuels for transmutation in a fast reactor. Mixed Oxide (MOX) fuel has an extensive fast reactor irradiation history and thus is being considered for use as a baseline composition from which minor actinides (MA) can be incorporated for use as a transmutation fuel. The current study involves characterization of precursor powders and pellets to be inserted into the Advanced Test Reactor in Idaho. These pellets will have three compositions: one standard MOX composition, $(U_{80}Pu_{20})O_{1.98}$, and two compositions of minor actinide mixed oxide (MA-MOX) with oxygen to metal ratios (O/M) of $(U_{75}Pu_{20}Am_3Np_2)O_{1.98}$ and $(U_{75}Pu_{20}Am_3Np_2)O_{1.95}$. The precursor powders were characterized using a field emission gun scanning electron microscope (FEG-SEM) for particle morphology, size, and size distribution. The pellets were characterized using an electron microprobe analyzer (EPMA) in order to determine impurities levels.

2:40 PM
A New Method to Recycle PET Bottles: *Václav Veselý*[1]; [1]J.Hanika Institute of Process and Fundamentals, Czech Academy of Science

PET bottles are separated and subsequently crushed into flakes. Except for PET, these flakes contain PE, PVC, paper, adhesives, beverages remainders and mineral impurities. PET itself usually is a glycol and terephthalic and isophthalic acid polymer. The suggested method consists in PET flakes crystallization at 255°C. In the meantime, volatile substances evaporate and

PVC disintegrates. Formed crystalline PET is crushed into small particles and then is subject to the basic hydrolysis at an atmospheric pressure. In addition to lye solution, glycol is added in the hydrolysis. Water is eliminated by boiling, which gives rise to suspension of sodium salt of terephthalic acid and glycol. The suspension is skimmed and the filtered glycol is vacuum distilled. Pure glycol is then the distillation product. Crystals are dissolved in water and the solution is filtered, which eliminates PE and impurities. Electrodialysis removes pure terephthalic acid salt from the solution. Glycol solution is returned to the hydrolysis. Terephthalic acid is precipitated by a mineral acid. Subsequently, it is washed and dried. The filtrate is separated through electrodialysis to lye and acid. The lye gets back to the hydrolysis and the acid is used for precipitation. Terephthalic acid and glycol are products in a "polymer grade" quality. The waste is a part of washing waters, distillation remainders after glycol regeneration and a filter cake after the terephthalate solution filtration.

3:00 PM

Amelioration of HCFA for Further Application in Oil Spill Clean Up: *Angeliki Moutsatsou*[1]; Ioanna Kavallari[1]; Olga Karakasi[1]; [1]National Technical University of Athens

The transportation of oil through sea and some routine ship operations are responsible for severe environmental damage, when the oil is spilled on the sea. Various remediation techniques have been applied, the most effective being the use of absorbent materials. This study investigates the efficiency of a solid inorganic waste material, high calcium fly ash (HCFA), as absorbent material for oil spill. The behaviour of HCFA, when added to oil spill, is encouraging due to its properties: chemical and mineralogical structure, fine particle size, floatability and porosity. Its sorption capacity varies from 1.5 to 3 g oil per g HCFA depending on its composition and the oil type. In order to ameliorate its floatability, the reduction of its specific gravity has been investigated by using light additives, such as sawdust and polymer. Further purpose of the study is the use of the mixture as a road construction material.

3:20 PM

Calcination of Dredged Sediments (Sludges) at Laboratory and Pilot Scales: Engineering of Properties for Beneficial Use: Jocelyn Ramaroson[1]; *Ange Nzihou*[1]; Jean-Louis Dirion[1]; Guy Depelsenaire[1]; [1]Ecole des Mines d'Albi-Carmaux

This study assesses the technology to treat heavy metals from dredged sediments using phosphoric acid (The Novosol process, developed by Solvay) with the goal of converting metals, mainly Pb, Cd, Zn and Cu to insoluble metallic phosphates, and engineering properties of the final residues for the beneficial use in civil engineering. This paper is focused on the calcination of the phosphated dredged sediment carried out at both laboratory and pilot scales. The most significant effect observed is the destruction of organics and the increase of the specific surface area (creation of pores) that reaches the maximum at 400°C, followed by the sintering process (densification and reduction of the porosity) from 400°C to 1000°C. The sintering at pilot scale is confirmed by the increase of the particle size. These results show the possibility of controlling structural properties of the residues for variable applications in civil engineering.

3:40 PM

Controlled Production Conditions and Characterization of Rice Husk Ash for the Synthesis of ZSM-5 Zeolite: *Konstantinos Kordatos*[1]; A. Ntziouni[1]; L. Iliadis[1]; S. Gavela[1]; K. Pistiolas[2]; A. Kyritsi[2]; V. Kasselouri-Rigopoulou[1]; [1]National Technical University of Athens; [2]Agrino, EV. GE. Pistiolas S.A.

The present work deals with the production and characterization of rice husk ash (RHA) and its use in the synthesis of zeolite of type ZSM-5. Rice husk was combusted in various temperatures with aim to find the suitable conditions for the production of amorphous silica. The resulted under the best experimental conditions amorphous silica ash was used as a starting material for the synthesis of ZSM-5 zeolite. ZSM-5 zeolites were synthesized using two different experimental techniques, the low temperature and atmospheric pressure and the autoclave processes. Both methods led successfully to the synthesis of highly siliceous zeolite of type ZSM-5. The produced materials were assessed through series of analytical techniques such as: X-ray diffraction, thermal-gravimetric analysis, scanning electron microscopy and fourier transformation infrared spectroscopy.

4:00 PM Break

Waste Conversion and Reutilization II

Monday PM — Room: Caesar 6
October 13, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Junko Umeda, Osaka University

4:20 PM Keynote

Generation, Recycling and Reutilization of Waste at Production and Operation of Catalyst for Chemical Industry in CIS: *Suvorin Alexander*[1]; Vladyslav Sokolov[2]; [1]Severodonetsk Technological Institute; [2]PTIMA NANU

The traditional technologies of manufacturing of the catalysts are considered with emphasis on waste generation. The valuable elements are lost in a form of dust at the operations on feedstock materials (proportioning, drying, mixing and agglomerating). Some part of the produced agglomerates becomes crushed. The thermal destruction is accompanied by carry-over of metal containing aerosols. The rate of feedstock utilization is demonstrated at the manufacturing stages by the example of the catalysts for methanol production. The general approaches for recycling spent catalysts are described. They should lie in adding the spent catalysts to the ore-base charge materials in metallurgy. More often the pure elements or sometimes compounds for catalysts are extracted by the specific hydro or pyrometallurgical approaches. However the best way is reutilization of the spent catalysts by their activation. Their applicability depends on a rate of their poisoning. The ways for reutilization more poisoned catalysts are shown.

4:45 PM

Development of a Multi-Stage Process for Reutilization of Coal Pond Ash: *Sung-Joo Lee*[1]; Hee-Chan Cho[1]; Nam-Il Um[2]; Gi-Chon Han[2]; Ji-Whan Ahn[2]; [1]Seoul National University; [2]Korea Institute of Geoscience and Mineral Resources(KIGAM)

In Korea, most of coal bottom ash produced by coal power plants is being disposed to the ash pond as slurry, and more than 80% of the coal power plant sites are occupied for the storage of the huge quantity of ash, which leads to environmental problems and managerial burden for plant operators. In this study, investigations were taken to develop a beneficiation process for separating the coal pond ash into valuable products for various applications. To improve efficiency of the separation, separating experiments were carried out using by various beneficiation processes. The results will be used for developing a multi-stage process to separate the coal pond ash in various products such as lightweight aggregate, sand, high-carbon fuel, and very fine inorganic fillers.

5:05 PM

Environmentally Benign Process of High-Purity Amorphous Silica Originated in Rice Husks of Agricultural Wastes: *Junko Umeda*[1]; Katsuyoshi Kondoh[1]; Yoshisada Michiura[2]; [1]Osaka University; [2]Kurimoto Company

High-purity amorphous silica particles from rice husks are possibly employed as raw materials in many products. Their purity strongly decides the utility value; for example, high-purity silica with 99% or more is available to be applied to high-end products such as additives for cosmetics and medicines. In this study, the advanced process to prepare high-purity amorphous silica originated in rice husks has been established and process parameters optimization in acid leaching and combustion of husks has been carried out. From an environmentally benign point of view, it uses carboxylic acid leaching instead of the conventional method by strong acid solution. In particular, citric acid and oxalic acid solutions are employed in this study,

and the effects of their concentration and temperature on the purity of rice husk ashes are evaluated. The investigation results indicate the possibility in recycling rice husks as useful materials such as fuels, energy and industrial resources.

5:25 PM

Fractal Phenomenon in BF Slag Leaching Process: Ping Wang[1]; Yuanchi Dong[1]; Hanlu Xie[1]; *Liang Yu*[1]; [1]Anhui University of Technology

The leaching process is the first step when recycling BF slag as raw material for some other products. While studying the kinetics of the BF slag leaching process, a fractal phenomenon was found, which indicated some interesting mechanism in the process. The result suggested a new understanding of the leaching process in detail which useful for the industrial application.

5:45 PM

High Temperature Techniques for Chemical Incorporation of Wastes Aimed to the Obtainment of Re-Products: *Isabella Lancellotti*[1]; Luisa Barbieri[1]; Fernanda Andreola[1]; Luciano Morselli[2]; Fabrizio Passarini[2]; Ivano Vassura[2]; [1]University of Modena and Reggio Emilia; [2]University of Bologna

The techniques able to incorporate wastes by means of a heat treatment present the advantage to fix the residue with chemical bonds. Among these techniques there are vitrification and sintering which are characterised by different operating temperatures in the range of 950-1500°C and the involved raw materials develop silicatic crystalline phases and glassy matrices capable to block the wastes. In this work incinerator bottom ash, polishing and glazing ceramic sludges have undergone to thermal treatments in order to valorise the waste as secondary raw material for the obtainment of re-product. The chemical efficiency of the process adopted has been evaluated by comparing the results of release tests applied to the as-received waste and to the thermally treated materials in order to verify the effectiveness of the different matrices to fix the wastes. Furthermore, some properties have been assessed to evaluate the material quality.

Zero Waste Workshop

Monday PM
October 13, 2008

Room: Miramar 4
Location: Hilton Cancun Golf & Beach Resort

Session Chair: J. Michael Huls, California Take It Back Partnership; R. V. Anthony, Richard Anthony Associates

Session I: Integrated Resource Management:

This session will address the techniques and implementation of a variety of programs and actions that change waste management into resource management. This session will first provide a comprehensive review of all technological aspects of resource management, from upstream to downstream, and include business sector as well as municipal sector activities. Mostly, this session will address clean production, cradle to cradle planning, and product design and EPR. The session will cover several case studies including Ricoh electronics and their five Rs, Urban Ore and its reuse activities, Vons and its composting program, and the development of resource recovery parks.

Session II: Organics Resource Management

Organic materials comprises 60% or more of what is commonly referred to as MSW, municipal solid waste. In some states, organics are even banned from landfilling. In this session, participants will learn about a variety of issues, the technologies, siting, environmental impacts, and marketing as it is currently done by many practitioners.

Session III: Supply and Demand

To set up programs at municipal levels or even at facility levels, it is required that resource managers have an expert understanding of the facets of wasting, how discards are generated, how they can be easily categorized for resource management purposes, and how they can be marketed. In this dual session, participants will learn about profiling their wasted resources as a supply for end uses, and learn critical aspects about markets and market demand, from local development to international trade.

Session IV: Moving Business to Clean Production and the Triple Bottom Line

This session is intended to bring participants up to speed with the need to move businesses to clean production, and to understand and adopt the triple bottom line as a resource management principle of business. Over 2000 companies in California right now have adopted zero waste to landfill, and are making money as well as protecting the environment through clean production and the TBL.

Exam

At the end of the training, participants will be given a short exam and an opportunity to obtain a Temporary Certificate of Completion in Integrated Resource Management issued by CRMTI.

Tuesday Plenary Session

Tuesday AM
October 14, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Christian Ludwig, PSI /EPFL

9:00 AM Plenary
From R'07 to R'09: "World Resources Forum" as a Platform for Resources Productivity: *Xaver Edelmann*[1]; [1]Mitglied Direktion EMPA

Abstract not available.

9:30 AM Plenary
Societal Impacts of Waste Management: *Brajendra Mishra*[1]; [1]Colorado School of Mines

Abstract not available.

10:00 AM Break

Case Studies in the Development of Waste Treatment Technologies II

Tuesday AM
October 14, 2008

Room: Caesar 8
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Toyohisa Fujita, The University of Tokyo

10:30 AM Keynote
Extraction of Gold, Silver and Copper from the Copper Electrorefining Anode Slime: Separation of the Metals: *Luis Sobral*[1]; Gabrielle Bard[1]; [1]Centre for Mineral Technology-CETEM

Copper sulphides Concentrates, from the flotation process of copper primary ores, contain, commonly, small amounts of precious metals, such as gold and silver. During the smelting process of those concentrate all gold and silver are practically in the blister copper, which is cast into anodes. Those copper anodes are electrorefined in an electrolytic system, where the electrolyte is an acid copper sulphate solution, where a high purity electrolytic copper is produced (>999,9/1000). The slime when submitted to an oxidative leaching process, using sodium hypochlorite and hydrogen peroxide as oxidizing agents, turn those metals into solution. This research practical work, apart from concentrating effort on the digestion of the anode slime, aims at evaluating the efficiency of the cementation process of the metals of interest for the separation of them to take place.

10:55 AM
Combined Process for Treatment and Recycling of Municipal Solid Waste with Complex Morphological Composition: *Lubomir Kuzev*[1]; Rumen Markov[2]; [1]University of Mining and Geology St. Ivan Rilski; [2]JBI – Ltd, Sofia

The treatment technologies for municipal solid waste (MSW) are effective mainly for components sized over 40-50 mm. This fraction is separated by screening in the beginning of the process. Usually the undersized product is deposited without additional treatment. Its quantity is variable from several up to 30-40% of the total MSW. Both oversized and undersized fractions are formed by all types of primary matter. Adapted technologies from mineral processing will provide a suitable technology for treatment of MSW under 40-50 mm. The MSW content depends on the geographical location, the degree of urbanization and other factors. The following methods can be applied for separations of different components suitable for recycling or other utilization: 1) Separation by density in vertical or horizontal stream. 2) Separation in thin liquid layer. 3) Selective grinding and screening. 4) Dense medium separation, etc.

11:15 AM Invited
Cost-Effectiveness of C&D Waste Recycling In Italy: A Case Study: Vittorio Basilico[1]; Marco Quattrone[1]; *Mario Bassan*[1]; [1]Technical University of Milan

In Italian building market one of the reasons that often stop building contractors from not taking into consideration the possibility to recycle rubble from building is represented by the misbelief that rubble separation causes an increase in costs because the demolition process is longer. In this paper the results of a testing conducted on a case study through economic and technical analyses are presented. Results highlight that a wise management of demolition and disposal processes can generate a remarkable saving and that it is possible, on the other side, to achieve environmental benefits such as reduction of raw material consumption and dump life lengthening.

11:35 AM
Development of Waste-Free Technology in the Steel Industry: David Esezobor[1]; Sanmbo Balogun[1]; *Samson Adeosun*[1]; [1]University of Lagos

Iron and steel making processes give rise to large amounts of usable and unusable materials, the latter generally being termed waste. It is sometimes difficult to distinguish between re-usable by-products and wastes which cannot be sold or land-filled. Much depends on circumstances such as the local market for the material. This can itself vary from time to time with by-products which cannot be used or sold becoming wastes and vice versa. This paper defines the concept of "waste-free technology", discusses its development in the steel industry and highlights the benefits of the technology to the manufacturing sector and the environment. The paper also articulates how the "waste-free" technology could be applied in the proposed Ajaokuta integrated steel plant. Key process areas with innovative low-cost technologies are identified.

11:55 AM
Flexible Technologies of Processing Textile Wastes into High Added Value Products: *Eftalea Carpus*[1]; Emilia Visileanu[1]; Razvan Scarlat[1]; Silvian Ionescu[2]; Alexandru Popa[3]; [1]Research-Development National Institute for Textile and Leather; [2]SC FI-RI Vigonia SA; [3]"Aurel Vlaicu" University of Arad

The environment protecting and the rational managing of the natural resources become priorities, within the context of economic developing and competitiveness ensuring in Romania. The flexible, economic and ecologic technologies that include systems of preliminary waste preparing (cutting, opening) and conventional and non-conventional systems of processing the recovered fibres are at the basis of substantiating the activity of implementing the zero waste notion. The activity of defining the valorification technologies of the technologic textile wastes or resulted from the production process aimed at the following aspects: - the technologic capacity of preliminary waste processing; - the characteristics of the recovered fibres (fibre length, unopened fibre percentage, unopened material waste percentage, melt percentage); - the ecologic impact over the environment and human health. The choosing of the technologic version of processing the wastes into high added value products is the option of a corresponding management, of a strategic course of activity.

Challenges and Strategies for Management of Electrical and Electronic Waste in Latin America and the Caribbean Workshop: Situation and Challenges of e-waste Management in Latin America and the Caribbean

Tuesday10:30 AM-12:30 PM Room: Miramar 4
October 14, 2008 Location: Hilton Cancun Golf & Beach Resort

Session Chair: Heinz Böni, EMPA

Input Presentations:

General Overview on the e-waste Situation in LAC: *Uca Silva*, Regional Platform on e-waste RELAC – SUR/IDRC, Santiago/Chile

E-waste Situation and Trends in OECD Countries: J*ohn Dickenson*, AER Worldwide, StEP Initiative, Fremont/USA

Legal Framework and the Role of Governments: *Leila Devia,* Basel Convention Regional Centre South-America, Buenos Aires/Argentina

EPR and Private Sector Involvement: *Ricardo Gonzalez Llera*, IBM, New York/USA

Regional Example: México: *Guillermo Román,* Instituto Politécnico Nacional México, México D.C.

Refurbishment and Reuse for the Civil Society: *Martha P. Castellanos,* Computadores para Educar, Bogota/Colombia

Clean Technology and Reengineering of Current Processes II

Tuesday AM Room: Caesar 5
October 14, 2008 Location: Hilton Cancun Golf & Beach Resort

Session Chair: Dieter Offenthaler, University of Leoben

10:30 AM Keynote
Possibilities of Removal of Hazardous Solid Waste at High Temperature by a Solar Furnace: *Inmaculada Cañadas*[1]; Diego Martinez[1]; José Rodríguez[1]; Andrés Navarro[2]; Bernardo Fernádez[3]; Alfonso Vazquez-Vaamonde[3]; [1]Plataforma Solar de Almería-Center for Energy, Environment and Technological Research; [2]Department Mecánica de Fluidos. E.T.S. Ing. Industrial (UPC); [3]Centro Nacional de Investigaciones Metalergicas-Consejo Superior de Investigaciones Científicas

Solar furnace is a solar beam concentrating device which is able to deliver high density energy fluxes, thus allowing temperatures over 2000C to be attained, and it is more advantageous than other heating devices because solids can be heated without any contamination to extremely high temperatures. Besides, current environmental issues give rise to the need of a clean, efficient way of hazardous solid waste removal. Concentrated solar power is also an option in this field. The motivation for development of solar-driven processes emerged from the fact that current recycling techniques furnaces are characterized by high energy consumption and concomitant environmental pollution, derived from the combustion of fossil fuels for heat and electricity generation. The use of solar energy as source of process heat avoids greenhouse-gases emissions and other pollutants derived from combustion of fossil fuels. Two new solar reactors developed and tested at PSA will be presented in this work.

10:55 AM
OxyFuel Combustion for Low-Caloric Fuels: *Werner Hoeltl*[1]; Tobias Pröll[1]; Hermann Hofbauer[1]; Michael Potesser[2]; Joachim Rohovec[2]; Bernhard Kronberger[3]; [1]Vienna University of Technology; [2]Messer Austria GmbH; [3]Fernwärme Wien

OxyFuel combustion is a key technology for the efficient separation of CO2 from fuel combustion (especially coal). Since coal plays a minor role in the Austrian energy mix the application of OxyFuel towards other fuels (biomass, waste fuels) is interesting to reduce greenhouse gas emissions from Austrian energy sector. The investigation of OxyFuel technology for alternative fuels is also interesting from a strategic point of view in order to generate knowledge for operation of capture ready cofiring and waste/sludge-incineration plants. OxyFuel uses a synthetic mixture of O2 and recycled exhaust gas where the O2 content may vary. This supplementary degree of freedom allows improved operation especially for low calorific fuels. Heavy fuel oil addition for low calorific combustibles can be omitted when using OxyFuel combustion. Application of alternative fuels (wood, waste wood, municipal waste, sewage sludge) in a 100-kW CFB plant is investigated in combination with process simulation.

11:15 AM
Proposal for Avoiding the Hot Acid Leaching Process in Zinc-Hydrometallurgy by Partial-Reduction of the Roasted Concentrates: *Dieter Offenthaler*[1]; Jürgen Antrekowitsch[1]; [1]University of Leoben

The paper introduces a process flow-sheet for hydrometallurgical zinc-winning, which allows to avoid the hot acid leaching process without lowering the zinc yield. The idea is to introduce the concentrate after roasting into a fluidized bed reactor, where the iron oxides are reduced to wustit and the zinc ferrites become destroyed. In the subsequent leaching process zinc and iron are easily leachable in diluted electrolyte from the electrowinning cells, while elements like Pb, Cu, Ag, As, Ge and Sb remain in metallic form in the leaching residue. To remove iron from the pregnant solution the next step is an oxidative hydrolysis of the iron-sulphate. The precipitation of the iron as FeO(OH) is done at temperatures between 110 and 120°C, at a pH between 4 and 5 and with ZnO containing materials (dross, ash, waelz-oxide) as neutralizing agent. The following steps are identical to conventional zinc-hydrometallurgy (purification and electrowinning).

11:35 AM
Recovery of Alkali and Removal of Iron from Alkali Roasted Ilmenite for the Production of Synthetic Rutile: Abhishek Lahiri[1]; *Animesh Jha*[1]; [1]University of Leeds

In this paper we describe a reduction leaching technique via which the alkali from the roasted ilmenite can be recovered together with the removal of remaining iron in the roasted product. During leaching of alkali roasted ilmenite for maximising the removal of iron both the pH and temperature must be optimised. The formation of various complexes of iron with ascorbic and oxalic acids are characterised in detail using FTIR by collecting samples at different time intervals of reaction. Scanning electron microscopy, X-ray diffraction and chemical analysis methods were used to ascertain the chemical composition of the final product obtained after the leaching process. Using the combination of alkali roasting and reduction atmosphere leaching processes, titanium dioxide of greater than 97% purity have been obtained as a beneficiated product for chlorination to TiCl4.

11:55 AM
Sludge Characteristics of a UASB/CO_2-Stripper System for the Treatment of High Strength Wastewater: Apostolos Vlyssides[1]; Sofia Mai[1]; *Elli Maria Barampouti*[1]; [1]National Technical University (NTUA)

A new anaerobic reactor variation, the UASB/CO2-stripper reactor was conceived. It consisted of a conventional UASB reactor that recirculated the biogas produced. The sludge characteristics of this system were examined when treating high strength wastewater. From the data collected, it was obvious that the UASB/CO2-stripper system can satisfactorily operate at higher loading rates (25 g COD•L-1•d-1). A pronounced effect on the quality of the granular sludge was observed. The VSS/TSS ratio decreased sharply. A considerable decrease in the mean granule diameter was observed, while the specific gravity of the granules increased. The sludge bed porosity increased

significantly leading to a considerable expansion of the sludge bed. These changes in the sludge properties led to a gradual shift of the system towards a fluidized bed process as far as its hydraulic characteristics were concerned.

Design and Engineering of Waste Treatment Plants

Tuesday AM
October 14, 2008

Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Richard Kunter, Samuel Engineering

10:30 AM Keynote
Reclamation of Industrial Waste Water from Galvanization Process: Mahmoud Rabah[1]; *Medhat Abdel Motelib*[1]; Fatma Farghaly[1]; [1]Central Metallurgical Research and Development Institute

Waste water from industrial galvanization industry was reclaimed under current flow stream conditions. Results showed that the raw water contains 7% by weight total suspended solids (TSS) causing turbidity amounting to 30. Measurements of Zeta potential as a function of pH revealed that solid separation takes place at pH 9. Oxygenated lime oxidized the soluble ions of iron and zinc metals to insoluble ferric oxide and zinc hydroxide Addition of 0.005% solution of cationic magna flocculants polymeric materials helps the rapid separation of the turbidity. Separation of floccules so formed takes place by filtration. Addition of peroxide ions to the agglomerating material helps the physical stability of the loaded water in the storage basin. Solid agglomeration takes place in few seconds. Maximum temperature for safe solid removal was <65°C. The treated water was pure and safe for recycling or use in domestic purposes.

10:55 AM
Compact System for Treatment and Recycling Bus Wash-Water by Flocculation Column Flotation: *Jorge Rubio*[1]; Rafael Zaneti[1]; [1]LTM

An experimental (continue) pilot-scale (1m3.h-1) study was carried out in a metropolitan bus company to evaluate the process of flocculation column flotation (FFC) as a new technique for the recycling of Bus Wash Wastewater (BWWW). The technique involves compacted flocculation - flotation unit, utilizing in-line hydraulic flocculators, centrifugal multiphase pump assisting the generation of microbubbles followed by column flotation (solid/liquid separation). The FFC design parameters were varied and the reuse-water had its chemical and physical-chemical quality evaluated. Yet, the new treatment system efficiency is compared with the running bus company water recycle system (ETAR system, from Aquaflot Industrial Ltda.). This ETAR system yields the recycle of more than 400.000m3 in the last 6 years. FFC showed a high hydraulic-load capacity (>18 m.h-1), low foot print and low energy consumption (flocculation in just 10s) and it is believed to have a great potential in this kind of water reuse.

11:15 AM
Dual Plant to Produce SHG Zinc and Pure Zinc Sulphate from Zinc Oxide Secondaries by Using Zincex™ Technology: *Carlos Frias*[1]; Maria Frades[1]; Ana Mejias[1]; Daniel Martin[1]; Gustavo Diaz[1]; [1]Tecnicas Reunidas, S.A.

In recent years, zinc recovery from flue dusts and other industrial wastes has been increased, offering to the market a large tonnage of secondary zinc oxides, which can not be processed directly to render high quality zinc because of the hazardous impurities and halogens content. The ZINCEX™ Technology has been commercially applied for more than thirty years and represents the most suitable solution to deal with secondary or crude zinc oxides due to its flexibility, simplicity, and cost-efficiency, allowing production of SHG electrolytic zinc and pure zinc sulphate salts thanks to the ability and selectivity of the zinc solvent extraction unit regarding to get read of impurities. A dual plant able to produce electrolytic zinc and crystallised zinc sulphate has been engineered to provide a flexible and profitable solution to zinc market. A description of the study is presented in this paper.

11:35 AM
Electric Pulse Disintegration: Russian Experience and Prospects: Anatoly Usov[1]; *Tsukerman Vyacheslav*[1]; [1]Kola Science Centre Russian Academy of Sciences

The use of the Electric Impulse Technology (EIT) for disintegration of materials in an industrial-waste processing are examined. The principles of EI-destruction have been described and a specific feature of multi-component material disintegration (a strongly selective character of destruction) has been explained. This ensures a high degree of disclosure of useful mineral grains in the process of disintegration and an essential increase in extraction and in improving the quality of concentrates at the next stage of ore beneficiation. The features and technological efficiency of EI-disintegration of various types of ores and the spheres of effective use of the method have been determined. The possibility of using EI-disintegration in special purposes, such as in deriving pure mono-mineral factions of a product for geological investigations of mineral raw material, has been shown. Possibilities have been shown for using EI-technology to resolve different ecological problems.

11:55 AM
Protection of Reinforced Concrete against Corrosion in Waste Treatment Plant (Case Study): *Magdelinka Yaneva*[1]; Emilia Kostakeva[1]; [1]University of Architecture, Civil Engeneering and Geodesy

One of the methods for waste treatment is composting during which as a result of controlled biological decomposition of organic waste in aerobic conditions harmless materials are received. Composting takes place in suitable designed premises which ensure the optimal conditions for biochemical decomposition of the waste. A usual way to process composting is disposition of the waste on the base made from reinforced concrete. In the paper are revealed the phases and basic technical features of the process of composting, the requirements and properties of the base and the ways of implementation protection of concrete base against corrosion. Technical decisions for a chosen construction site in Bulgaria are shown and the advantage of achieving durability of the concrete constructions in the plant with simultaneously environment protection from pollution is discussed.

Environmental Issues Related to Waste Storage and Recycling II

Tuesday AM
October 14, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Kiichiro Hayashi, Nagoya University

10:30 AM Keynote
Remediation of Soils Contaminated by Dioxins and Furans: *Väinö Hintikka*[1]; [1]Geological Survey of Finland

In the study was developed the method for the treatment soils contaminated by poly-chlorinated di benzodioxin and dibenzofuran. The method is based on attrition of soil so that the contaminants absorbed on the particle surfaces are liberated with the fine fraction formed in the attrition process. Same the attrition process produces active surface which can absorb the free contaminants. Before starting the remediation process must be decided the limit value under which the residual concentration must lie. Then in the laboratory is performed an experiment in the base of which is determined the grain size level; material under which much be removed together with the contaminant. In the real sample has been found that after the attrition the limit value 0.5 ng/g (I-TEQ) is obtained when the fine under 0.1mm fraction (20% of the original soil) is removed together with the contaminant (original level 10 ng/g).

10:55 AM

Production and Industrial Adaptation of Fast Single Firing Wall Tile Opaque Glass-Ceramic Glazes Containing Borax Solid Wastes: *Keriman Karaveli Pekkan*[1]; Bekir Karasu[1]; Ali Kucuk[2]; [1]Anadolu University; [2]Kaleseramik A. S.

Zircon (zirconium silicate) is the main opacifier of glossy, opaque, white colored, frit-based wall tile glazes. However, zirconia containing frits employed in the preparation of these glazes increase the production cost and therefore, limit zircon usage as a raw material at industrial scale. With the present study, it was searched whether borax solid wastes could be evaluated as a component in the starting relevant frit recipes. The wastes were obtained from Eti Maden Kirka Boron Company of Turkiye. Frit production, glaze preparation, application, and fast single-firing of glazed wall tiles were conducted under laboratory working conditions in Anadolu University, Department of Materials Science and Engineering laboratories. Beside standard tests applied to the final glazed wall tiles, color and gloss analyses of the fired glazes were conducted with a spectrophoto-meter and a gloss-meter. Characterization of these newly produced glass-ceramic glazes was made by X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) techniques.

11:15 AM

Reduction of Sulfur Dioxide Emissions: *Vladimir Lobanov*[1]; Nikifor Ageev[1]; Alexander Pritchin[1]; [1]Ural State Technical University

Sulphurous anhydride is very voluminous technological emissions. The possibility of high-temperature SO_2 oxidations without catalyst in presence of calcium-bearing filling materials (CaO, $Ca(OH)_2$, $CaCO_3$) with obtaining of binding on the basis of waterless calcium sulphate is studied. Using the application package HSC-4 the thermodynamic analysis of the interactions is made. Following conclusions are drawn: 1) Reactions are feasible in the all range of temperatures (400–1000°C); 2) The best results should be expected at use of CaO; 3) The heat of reaction does possible autogenous behavior of process. The researches have shown: 1) SO_2 oxidation without catalyst is feasible in presence of CaO, $Ca(OH)_2$, $CaCO_3$; 2) The optimum temperature range is 600-800°C; 3) The content of waterless calcium sulphate in a product reaches 48% that makes it possible to use as the binding material; 4) At excess of CaO the degree of SO_2 collection is nearer to 100%.

11:35 AM

Slag Valorization: Relevance of Standard Protocols to Evaluate Environmental Impacts: *Priscilla Pareuil*[1]; François Bordas[1]; Emmanuel Joussein[1]; Hubert Bril[1]; Jean-Claude Bollinger[1]; [1]Groupement de Recherche Eau, Sol et Environnement

According to the legislation, valorization type, origin and characteristics of waste material, various standard procedures are available to evaluate environmental impacts. A Mn-rich slag was sampled from a metallurgical plant. After its characterization (elementary analysis and mineralogy), five standard procedures were carried out (*i.e* TCLP, EN 12457…). Each fixed parameter of the standards was systematically studied: pH, L/S ratio, contact time. For example, EN 12457 led to a low ME mobilization, increasing with the L/S ratio, the contact time and an acidic pH. Moreover, in reducing conditions, parameter not considered in the standards, Mn could be release about 40 times higher than with the original procedure. Then, the representativeness of the considered parameters and their potential variations are predominant for assessment of the real environmental impact during slag reuse. Moreover, the solid characterization before and after leaching tests is obviously important to understand release mechanisms.

11:55 AM

The Modification of Pyrite and Arsenopyrite Specific Surface and Porosity at Thermal Decomposition: *Vladimir Luganov*[1]; E. Kilibayev[1]; B. Mishra[1]; T. Chepushtanova[1]; [1]K.I. Satpaev Kazakh National Technical University

The paper contains the results of studying about modification of pyrite and arsenopyrite specific surface and porosity at their thermal decomposition. The studying of specific surface was carry out by B.E.T. - adsorption of nitrogen at his boiling-point. In our work were using the electron-microscopical, X-ray structure analysis and chemical analysis. Was established that the decomposition of pyrite and arsenopyrite accompany by increasing of pores volume from $0.303 \cdot 10^{-3}$ to $1.23 \cdot 10^{-3}$ at increasing of pyrite degree of decomposition about 41% and then decrease about $0.131 \cdot 10^{-3}$ m^3/kg at degree of decomposition near 100%. The surface area of pores increase from 0.31 to 1.085 m^2/g with following lowering due to enlargement and confluence of minor, small pores. Increasing of porosity accompany with increasing of particles windage that appear the result of heightened dust furnace partially decomposing pyrite and arsenopyrite particles by air flow from furnace reaction zone. This explains heightened contention of sulfide sulfur in roast dust of sulfide concentrate.

12:15 PM

Utilization of Borax Solid Wastes in Fast Firing Porcelain Tile Glass-Ceramic Glazes under Industrial Working Conditions: Bekir Karasu[1]; Guray Kaya[1]; *Selvin Yesilay*[1]; Asli Cakir[1]; [1]Anadolu University

In this investigation, the wastes of Eti Maden Kirka Boron Company of Turkiye were evaluated in the production of diopside and anorthite-based glass-ceramic glazes suitable for porcelain tiles which were fast and single fired under industrial conditions. First of all, high wear resistant frits were produced with the use of concentrator and derivative borax wastes. Second of all, pre-engobed porcelain tile bodies were coated with the standard and newly produced frit-based glazes and industrial single fast firing was employed. Final products were undergone to the certain standard tests to determine their Vickers hardness, wear resistance, thermal expansion coefficient values, gloss and coloring parameters. The microstructures and phase formations of the fired glazes were also investigated. Consequently, it was confirmed that the utilization of borax solid wastes in fast fired porcelain tile glass-ceramic glazes is possible.

General Recycling and Solid Waste Processing: Aluminum By-Product Recovery and Secondary Production II

Tuesday AM
October 14, 2008

Room: Miramar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: David Leon, Alcoa Inc

10:30 AM Keynote

Remelting of Aluminum Scraps: A Review: *Lifeng Zhang*[1]; [1]Missouri University of Science and Technology

The paper reviews the current techniques of the recycling of aluminum scraps, including aluminum scrap types and properties, decoating of aluminum scraps, and remelting methods of aluminum scraps. Remelting furnace techniques are reviewed, including reverberatory furnace, rotary furnaces, salt-free thermal plasma furnaces, and salt-free rotary Arc furnace with graphite electrodes. The burner technologies and the design of aluminum remelting through mathematical modeling are also summarized.

10:55 AM

Recovery of Metal Aluminum from Aluminum Dross in DC Electric Arc Rotary Furnace: Biserka Lucheva[1]; *Tzonio Tzonev*[1]; [1]University of Chemical Technology and Metallurgy

Recycling of aluminum scrap and dross is significant in the economic and energy saving, as well as in the environmental protection. Recovery of metal aluminum depends on many factors. The aim of this work is to investigate experimentally the metal recovery under different conditions. The processing of aluminum dross was carried out in DC electric arc rotary furnace. The optimal technological parameters are determined. It is turned out that the presence of crushing refractory bodies during the processing of the aluminum dross in the rotary furnace increases the degree of aluminum recovery with about 10 %.

11:15 AM

The Energy and Environmental Implications of Recovering Salt Flux from Salt Slag Generated by the Aluminum Industry: *John Hryn*[1]; [1]Argonne National Laboratory

Recycling aluminum at secondary smelters usually involves the use of salt fluxes to improve aluminum recovery. Unfortunately, the use of salt fluxes results in the generation of a salt slag (or salt cake) waste stream. Attempts at developing a viable salt cake recycling technology to date have been unsuccessful, primarily due to the high energy cost of recovering a usable salt fraction from salt cake. This paper discusses the overall negative energy and environmental implications of recovering spent salt flux from salt cake for reuse by the aluminum industry. From an energy and environmental perspective, the best practice today is to maximize aluminum recovery from salt cake and dispose the salt and NMP fractions in a controlled landfill. This approach to salt cake management is practiced by leading secondary aluminum companies.

11:35 AM

The Recycling of Electrofilter Fines to Produce Aluminum Sulfate: *Julia Ayala*[1]; José Sancho[1]; Purificación García[1]; Begoña Fernández[1]; [1]Universidad de Oviedo

Electrofilter dust, a residue generated in the last stage of the Bayer process in the hydroxide aluminum calcination, was characterized to evaluate the alumina that was potentially extractable with sulfuric acid. The process studied aims to produce aluminum sulfate for water coagulant uses, taking advantage of the residues that accumulate in large quantities in the proximity of plants with difficult recycling for storage. Acid leaching is carried out at different concentrations of sulfuric acid, at different temperatures, pulp densities, and times, to dissolve gibbsite and transition aluminas. The result is an aluminum sulfate solution without iron and with commercial specifications.

11:55 PM

Waste Treatment, Sand and Red Mud, in CVG-Bauxilum: *Ricardo Galarraga*[1]; Mario Pietroniro[1]; [1]CVG Bauxilum

From 1983, CVG-Bauxilum, before CVG-Interalumina, has generated an amount of waste near the 25.000.000 of cubic meters between sand and red mud product of the alumina process. Initially with an installed capacity of 1.000.000 tons/year, the Plant reached this value until 1992 when the capacity up to 2.000.000 of tons/year. Evidently alumina production increasing meant proportional increase of the amount of waste of red mud and sand. This work compiles the actions done by CVG-Bauxilum to handle the waste areas. Increase the capacities of the deposition ponds, reused the overflow liquor in the process, increase evaporation area to take benefit from the atmospheric parameters, to reduce the pH in the overflow ponds to be able to prepare it like spill to the river, study of use red mud like raw material for to make bricks, is of the processes impelled by CVG-Bauxilum to control the impact of these wastes.

General Recycling and Solid Waste Processing: Composite Materials I

Tuesday AM
October 14, 2008

Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Mohini Saxena, Advanced Materials and Processes Research Institute

10:30 AM Keynote

Demonstration Study on Impact of Fly Ash on Soil Fertility and Crop Yield: *Mohini Saxena*[1]; P. Asokan[1]; Bhisham Yadav[1]; S. Murali[1]; Hemraj Dangi[1]; [1]Advanced Materials and Processes Research Institute

Studies regarding use of fly ash as soil modifier and micronutrients supplier to land were carried based on the process optimised at AMPRI, Bhopal. The Field trials conducted in Uttar Pradesh, Orissa and Madhya Pradesh under different soil/ crop conditions where 100-650 tones per hectare fly ash were applied depending upon the soil and fly ash characteristics. Detail studies on impact of fly ash on soil and food quality were conducted. Yield of tomato, cabbage, potato, wheat, pea, onion, paddy, sunflower, maize increased from 12–46% as compared to the control soil. The crop response mainly to heavy metals grown in soil and fly ash admixed soil were found comparable to safety norms. Results of trails in different parts of India are mentioned in the study. Outcome could act as a guiding force for confidence building and maximise the use of fly ash as a major waste for agriculture purpose.

10:55 AM

Comparative Characteristics of Paints Developed from Fly Ash, Copper Tailing and Blue Dust: *Mohini Saxena*[1]; Sangeeta Tiwari[1]; [1]Advanced Materials and Processes Research Institute

Recycling and reuse is the best way to solve the problem of industrial waste disposal. Industrial wastes like fly ash, copper tailings are used for brick manufacturing, land filling, embankments filling etc. This study reveals the value addition of industrial wastes like fly ash, copper tailing and blue dust as an extender in Paints. Fly ash copper tailing and blue dust were characterized for physical, chemical and mineralogical properties and used for considering in paints application. Performance of fly ash and copper tailing paints were evaluated by comparing those of conventional whiting extender and blue dust was compared with conventional iron oxide use in priming coats. Extender properties of these new material and paints prepared out of blue dust, fly ash, copper tailing, were found better than the existing related materials.

11:15 AM

Comparative Performance Analysis of Bituminous Mixtures with EAF Steel Slags: A Laboratory Evaluation: *Marco Pasetto*[1]; Nicola Baldo[1]; [1]University of Padova

The paper presents the results of a laboratory study, conducted at the Experimental Road Laboratory of the University of Padova, in order to verify the possibility to use different types of electric arc furnace (EAF) steel slags - in substitution of the natural aggregates - in the composition of both dense graded and porous asphalt mixes for flexible road pavements. The research has been articulated in a preliminary study of the chemical, physical, and mechanical properties of the EAF steel slags, and in the following mix design and performance characterization of the bituminous concretes, through stiffness modulus tests at various temperatures and permanent deformation (creep) tests. All the mixtures with EAF slags have satisfied the requisites for acceptance standardized for the road sector, thus resulting as suitable for use in the construction of infrastructures, moreover presenting higher mechanical characteristics than those of the corresponding asphalts with full natural aggregate.

11:35 AM

Composite of High-Density Polyethylene Matrix Reinforced with Aluminum/LDPE from Beverage Cartons: Carolina Niedersberg[1]; Adriane Lawisch Rodríguez[1]; Cláudia Mendes Mählmann[1]; *Diosnel Rodríguez Lopez*[1]; [1]Universidade de Santa Cruz do Sul

The increasing use of beverage cartons and consequently the amount of their waste, has caused environmental problems, because to be discarded in landfills hinder compaction and undermine the decomposition of other materials. In this context, comes the importance of recycling such waste. The present work was to evaluate the performance of the Aluminum/LDPE from beverage cartons when added as strengthening the matrix of HDPE post-use, in order to obtain a composite material. We evaluated the mechanical properties of composite materials (with different levels of Al/LDPE) obtained by injection and by pressing term. Results of the survey showed that the composite does not have advantages in relation to the mechanical strength of the pure material, however, the addition of Aluminum/LDPE could increase the electrical conductivity and the chemical resistance of the polymer. Essays supplementary scanning electron microscopy, rate of flow and behavior opposite weathering should still be made.

11:55 AM

Cost-Benefit Evaluation of Ramie Waste Reinforced Composites as Substitute for Conventional Building Materials: *Sergio Monteiro*[1]; Frederico Margem[1]; Luiz Fernando Santos[1]; Felipe Lopes[1]; [1]State University of the Northern Rio de Janeiro - UENF

Natural fibers are gaining attention as a class of low cost, biodegradable and renewable materials that also exhibit some interesting properties for specific applications. In particular, the incorporation of some natural fibers in polymeric matrix composites is nowadays providing opportunity of manufacturing a variety of industrial items, for instance automobile interior components. Among these fibers, ramie (Boehmeria nivea) is one of the least investigated and only recently was studied as polymeric composite reinforcement. Therefore, the objective of this work was to evaluate the possibility of ramie waste reinforced polyester composites to replace conventional building materials, such as plywood, plastic boards and gypsum panels in terms of cost-benefit analysis.

12:15 PM

Effect of Piassava Waste Fiber Surface Treatment on the Reinforcement Strength in Epoxy Composites: *Sergio Monteiro*[1]; Denise C. Nascimento[1]; Ludy Motta[1]; [1]State University of the Northern Rio de Janeiro - UENF

Natural cellulose-based fibers are nowadays of growing interest for modern industrial composites. Relatively unknown fibers like piassava, curaua and gourde have shown promising behavior as reinforcement of polymeric composites. However, the hydrophilic characteristics of the natural fibers impair its adhesion to the normally hydrophobic polymeric matrix. Surface treatments can, in principle, improve this adhesion and the fiber/matrix interfacial strength. In this paper, the effect of alkali treatment of the surface of piassava (Atallea funifera) waste fibers was investigated in terms of the change in strength of epoxy composites reinforced with these waste fibers.

General Recycling and Solid Waste Processing: Heavy-Metal Containing Waste I

Tuesday AM
October 14, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Simona Regenspurg, EPFL / PSI

10:30 AM Keynote

Different Alternatives to Recycle the Industrial Wastes: *Nour-eddine Menad*[1]; Solène Touzé[1]; Maurice Save[1]; [1]Bureau de Recherches Géologiques et Minières

This paper gives the overview of different alternatives to recycle the following wastes: slag, dusts, wastes of electric and electronic equipment (WEEE) and auto shredder residues (ASR). Based on modified Bogue calculations, steelmaking slags were combined in order to produce a belite-rich clinker activated with sulphoaluminate. The EAF dusts containing significant amount of metals can be recycled in different ways: The carbothermal treatment and INTECT process are reported. The results obtained from the model of Auto Shredder Residue injection into blast furnace show that ASR can be used as reducing agent in the BF process if certain conditions are met. The particle size of this material must be controlled to ensure optimal gasification of the material in raceway. The non-ferrous contents may affect the pig iron quality, which is difficult to rectify at a later point. It seems the pyrolysis is the most attractive process to handle ASR.

10:55 AM

A Method of Treating the Leaching Residue from Sered Nickel Plant Stockpile: *Juraj Schmiedl*[1]; Felix Sekula[1]; František Molnár[1]; Zsolt Szentirmai[1]; [1]Technical University of Košice

Hydrometallurgical nickel production in Sered Nickel Plant (Slovakia) that treated roasted Albanian ore left behind a considerable amount of the solid leaching residue. About 6 million tons of this fine-powder residue containing approximately 52 wt.% of iron in the form of oxides is to the present day stored in a stockpile. However, its iron content makes it a potentially interesting secondary raw material for iron production. This secondary raw material is not, unfortunately, suitable for direct treatment in iron and steelmaking processes. This paper presents results of the laboratory tests of pyrometallurgical method of processing of the leaching residue by its roasting and subsequent refining melting. The objective of the selective reducing agglomeration roasting was to reduce iron oxides and to simultaneously avoid reduction of chromium oxides and silica. Refining melting is carried out in an inert atmosphere. The products of melting are technically pure iron and slag.

11:15 AM

Characterisation of Zinc Containing Residues from Metallurgical Processes: *Juergen Antrekowitsch*[1]; [1]University of Leoben, Austria

The recovery of valuable metals from residues like dusts and sludges is nowadays state of the art. Depending on the complex constitution, a recovery of different metals can in the majority of cases only be performed with considerable energy input in high temperature processes together with insufficient yields and newly generated residues. Often, the behaviour of the dust or sludge in the process during melting or reduction is unknown. In this work, a detailed characterization of selected residues like steel mill filter dusts, cupola furnace dusts and leaching residues is done. The different steps of getting from solid particles into a homogenous liquid phase were investigated. Even high temperature processing lead to high reaction speeds, the complexity of residues keeps the system away from thermodynamic equilibrium. With this research program, some basics are generated to understand smelting and reduction and to explain the gap between thermodynamical calculations and real behaviour.

11:35 AM

Chemical and Thermal Treatment of Dredged Sediments (Sludges): Modification of Heavy Metal Mobilities: Jocelyn Ramaroson[1]; Jean-Louis Dirion[1]; *Ange Nzihou*[1]; Patrick Sharrock[2]; Guy Depelsenaire[3]; [1]Ecole des Mines d'Albi-Carmaux; [2]Université Paul Sabatier; [3]Solvay

The deposit of sediment causes the silting of channels, rivers. This leads to clogging of rivers, with a reduction in their flow rates. Consecutively, other problems appear, such as flooding risks and loss of the biodiversity. This study assesses the technology to treat heavy metals from dredged sediments from different origins using phosphoric acid (The Novosolâ process, developed by Solvay) with the goal of converting heavy metals to insoluble metallic phosphates. The effectiveness of the treatment was evaluated by performing the chemical reaction, followed by drying and finally calcination (500°C-700°C). Leaching tests for the phosphated sediments, dried then calcined at different temperatures, were used and developed in order to define the influence of the chemical and calcination on the mobility of heavy metals The treatment decreases the mobility of most metals. Thus chemical and thermal treatment combined converted contaminated sediments into a new material which can be recycled safely.

11:55 AM

Effect of the Composition on the Immobilization of Chromium in Slags: *Jose Romero-Serrano*[1]; Elda García-Ramos[1]; Beatriz Zeifert[1]; Patricia Flores Sánchez[2]; Elia Palacios-Beas[1]; José Hallen López[1]; [1]National Polytechnic Institute; [2]Intituto Mexicano del Petroleo

Chromium containing slags from stainless steelmaking may be leached by acidic environments and they must be treated before being stockpiled or land filled. In this work, synthetic slags were prepared and the effect of CaO/SiO2, Cr2O3, MgO and Al2O3 contents on the stability of the mineralogical species formed was analyzed. The morphology and composition of the slags were analyzed by XRD and SEM-EDS, whilst their chemical stability was evaluated by leaching with an aqueous acid solution. It was found that CaCr2O4 and CaCrO4 are present in slags prepared with neither MgO nor Al2O3. The Al2O3-based slags produced Ca2Al2SiO7 and the Cr(IV)-containing oxide complex Ca4Al6CrO16, whilst MgO-based slags produced MgCr2O4. The results showed that the lowest chromium concentration levels in the leaching liquors corresponded to MgO-based slags. It was observed in the Al2O3-based slags that increasing the basicity from 1 to 2 the leachability of the slags are notably increased.

General Recycling and Solid Waste Processing: Lead

Tuesday AM
October 14, 2008

Room: Caesar 4
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Michael Potesser, University of Leoben

10:30 AM Keynote

Economic and Ecological Lead Furnace Improvements: *Michael Potesser*[1]; Burkhardt Holleis[2]; Helmut Antrekowitsch[1]; Davor Spoljaric[3]; [1]University of Leoben; [2]Messer Austria GmbH; [3]LLC Elme Messer Gaas

Due to higher energy costs and an economic driven force to substantially increase the melting rate by lowering the specific production costs, the Oxyfuel burner is the only applied system in the lead industry with the advantages of a higher combustion efficiency, low investment costs and therefore a small return on investment. The diluted combustion by an internal off gas recirculation solves the problem arising from a high flame temperature by overheating the melt and the refractory material in small areas of the furnace. More homogeneity of the melt and refractory temperature, a higher convective term of the heat transfer and a high amount of radiation is the solution to an economically and ecologically advantageous lead production. This paper describes the well established Messer Group GmbH. Oxipyr®-burner technology and a revamping of a lead short drum furnace from heavy oil air burners to the Oxipyr®-Flex flame methane oxygen burner system.

10:55 AM

Disposal of the Lead-Containing Wastes at IMN's Division in Legnica: *Zbigniew Smieszek*[1]; Ryszard Chamer[1]; Zygmunt Kurek[1]; Ryszard Prajsnar[1]; [1]Instytut Metali Niezelaznych

Lead-containing wastes processed at the IMN's Division in Legnica originate mainly from dry and wet dedusting installations of the technological lines for copper production. These are lead dusts and lead-zinc dusts characterised by the specific properties resulting from the chemical composition of the Polish copper concentrates. Besides lead, they contain many accompanying metals and impurities such as zinc, copper, sulphur, chlorine, potassium, sodium, and also bituminous substances. Processing of lead-containing dusts is conducted in the installations of rotary-rocking furnaces heated with gas-oxygen burners fitted with auxiliary systems for cleaning process gases and refining re-circulating dusts. The processing technology utilises innovative process and technical solutions enabling disposal of lead-containing wastes from copper metallurgy and from non-ferrous metals industry according to the BAT recommendations and to the guidelines specified in integrated permission. In this paper, the main technological aspects of processing lead-containing dusts at the IMN's Division in Legnica have been presented.

11:15 AM

Hydrometallurgical Process for Treatment of Slag Resulted from Processing of Waste Lead – Acid Batteries: *Teodor Velea*[1]; V. Predica[1]; L. Gherghe[1]; D. Taloi[2]; I. Constantin[2]; [1]National Research and Development Institute for Non-Ferrous and Rare Metals; [2]University "Politehnica" of Bucharest

Slag with high lead content are the result of wasted batteries processing through reducing melting in short rotary furnace. The article presents a treating method of the slag that could make possible the recovery of lead; the method consists in lead leaching in sodium chloride solutions in weak-acid and oxidizing medium at temperatures greater than 100°C and pressure of 2-3 atmospheres in the autoclave. The obtained solutions are purified by hydrolytic removal of Fe, Cu, Cd and other impurities. Lead from purified sodium chloride solution takes the form of a hydroxide or carbonate of lead through treating with sodium hydroxide or sodium carbonate solutions. Lead carbonate is processed through reducing melting in order to obtain metallic lead.

11:35 AM

Processing of Um-Gheig Lead-Zinc Deposits, Eastern Desert, Egypt for Separating Pure Cadmium Sulfide: *Mohamed Mahdy*[1]; Mohamed El Shahat[2]; Omneya ElHussaini[1]; Galal Abd El Wahab[1]; [1]Nuclear Materials Authority; [2]Ain Shams University

Lead-zinc mineralization is distributed in Egypt along the Red Sea coast between El Qusier and Ras Banas. A representative sample from Um Gheig was collected and ground to -60 mesh for the mineralogical study. It contains hemimorphite (Zn2SiO4.H2O), sphalerite (ZnS), galena (PbS), calcite (CaCO3), dolomite CaMg (CO3)2, calcophanite (ZnMn3O7.3H2O) beside gypsum (CaSO4, 2H2O). Cadmium seems to be incorporated in the crystal structure of the zinc-lead minerals. The chemical analysis of Um-Gheig representative sample revealed that, it contains 16% zinc combined with 0.1% cadmium and 2.3% lead, 0.1% boron beside other elements. Pug and agitation leaching were performed on samples ground to -200 mesh to achieve the maximum dissolution efficiency of cadmium with respect to other elements. Cadmium leaching efficiency reached 90% by using 40% H2SO4 at S/L ratio 1/2 and stirring time 2 hours at 80°C. Cadmium was then separated as yellow precipitate of CdS from the sulfate leach liquor containing 0.9 g/l Cd, 145 g/l Zn, 0.15g/l B and 0.01 g/l Pb. Separation of cadmium was carried out by direct precipitation using Na2S as well as H2S. The recovery of 94% cadmium free of zinc was achieved.

11:55 AM

Refinement of the Secondary Lead Received from Accumulator Scrap: Pavel Arkhipov[1]; Yurii Zaikov[1]; Viktor Ashikhin[2]; *Yuliya Khalimullina*[2]; [1]Institute of High Temperature Electrochemistry; [2]Uralelectromed

Lead alloys electro-winning from chloride melts was under investigation. Impurities concentration in cathode lead is strongly depended on temperature, electrolyte composition, anode current density. The equilibrium electrode potentials of lead-antimony alloys with the various content of electropositive metal in the alloy were investigated in the wide temperature interval. Thermodynamic properties of Pb-Sb alloys containing 20-95 mol% of Pb were studied by EMF method in temperature interval 723-873K in molten mixture of potassium and lead chlorides. Partial and integral thermodynamic characteristics were calculated. Small negative deviations from Raul's law were found. Anode processes were investigated. The lead dissolution was found to be the only process in certain interval of current densities and electropositive metal content in alloy.

12:15 PM

Treatment of Some Liquid Waste Associated with Lead Battery Recycling: *Carla Lupi*[1]; Alessandro Pescetelli[2]; [1]University of Roma La Sapienza; [2]Texeco Consulting

Spent lead battery recycling still shows few weak points in the achievement of a 100% recycling of different waste matters and by- products arising from the recycling process. Some of said problems are dealing with aqueous streams outgoing the recycling plant, and more particularly, a) the waste waters discarded from the breaking and separation unit, b) purification of the spent electrolyte drained from waste batteries and upgrade to a quality compatible with full re-use by the batteries' manufacturers, c) purification of the mother liquors discarded in the sodium sulfate crystallization process so to produce a salt of commercial grade. All of the above listed problems have been satisfactorily overcome applying an electrochemical process that, through different process conditions and parameters, is able to remove the harmful impurities that hinder the successful commercialization of such by products, or, at least, that can avoid heavy and expensive treatment plant and operation.

International Papers on Zero Waste Panel Discussion

Tuesday AM
October 14, 2008

Room: Caesar 6
Location: Hilton Cancun Golf & Beach Resort

Session Chairs: R. V. Anthony, Richard Anthony Associates; J. Michael Huls, California Take It Back Partnership

10:30 AM

Zero Waste is the New Peace Movement: *Eric Lombardi*[1]; [1]Eco-Cycle Inc.

A major source of conflict and violence on Earth has always been, and will increasingly become, the race to gain access to the last remaining deposits of virgin natural resources. The villages in Africa, Asia and Latin America that sit on or near important mineral or timber resources will be impacted heavily, and sometimes fatally, by that global competition to gain access. The issue of resource conservation, especially in the developed West, is not only a current economic and technical trend, but should also be seen as an ethical imperative. The transition from a throw-away culture into a Zero Waste Economy is a powerful resource conservation strategy and should become community policy.

10:50 AM

What the Plastic Industry Must Do If We Are to Keep Plastic out of Marine Debris and Get to Zero Waste: *R. V. Anthony*[1]; [1]Richard Anthony Associates

The reuse and recycling/composting of fiber and organic material and the recycling of textiles, ceramics, metal, glass, can be found as an industry in all cultures in the world. The use of plastic for durable goods and packaging is increasingly taking the place of other materials. The result has been an increasing amount of plastic materials being sent to landfill and incinerators that are subsidized by the general public. The Plastic Industry needs to develop a closed loop recovery system and include recovery in the product design. RAA recommends that the industry perform a cradle to cradle analysis of its products and plan for recovery and reuse. The industry must design packages and product for dismantling and recycling and include post consumer content. Products must be tested as a precautionary principal for human impacts before allowed to be distributed. The manufacturing systems must be clean without residual runoff. All plastic types must be labeled or signaled in such a way as they may be recognized for recovery. The industry must create the plastic equivalent of the scrap yard or paper yard to receive clean products from self hauled and private businesses. If the plastic industry creates recovery loops for their products, businesses will be the first to take advantage of the savings, and once established the government programs will follow. As cities across the world endorse zero waste goals, industry could be proactive or they can wait until government makes them do it.

11:10 AM

Total Participation Key to Successful Zero Waste Program: *J. Michael Huls*[1]; [1]California Take It Back Partnership

Huls provides an overview of public education within the framework of successful zero waste efforts. He will present the five keys to total participation. He will provide case studies of successful efforts (explaining what it takes). He will also identify the future of education and outreach, where emphasis is on digital media including cell phones, computers, web sites, and wi fi.

11:30 AM

Climate Change and Trash: *Brenda Platt*[1]; [1]Institute for Local Self-Reliance

Wasting is linked to core contributors of global climate change such as industrial energy use, transportation, and deforestation. Preventing waste and expanding reuse, recycling, and composting — that is, aiming for zero waste — is one of the fastest, cheapest, and most effective strategies available for combating climate change. Reducing U.S. waste generation 1% each year and diverting 90% of waste from landfills and incinerators by the year 2030 could offer climate protection benefits equivalent to closing 21% of the coal-fired power plants in the U.S. This presentation will highlight these and other findings and policy recommendations of the recently released report, Stop Trashing the Climate.

11:50 AM

The Need For Clean Production and Product Re-Design: *Muna Lakhani*[1]; [1]Institute of Zero Waste in Africa

In Zulu, in South Africa, that is how we greet each other. It translates as "I see you". It is an acknowledgement of self, and that we are all people together. Likewise, it reflects the African philosophy of Ubuntu which holds that we are all connected, and that people are people because of people. This appreciation of interconnectivity lies at the heart of a Zero Waste approach to environmental sustainability. The understanding that all are interconnected, and that any action affects all and everything, underpins the need for a rapid implementation of Clean Production, led by Product Redesign. This is so because any toxins introduced at any point of the design cycle will impact on all and everything, somewhere along the line. It's a philosophy that encompasses an understanding that production must be clean, from cradle to cradle (fully and safely recyclable), beginning with the very materials that are used in the first place. Begin with a sustainable product, that uses a sustainable process, based on sustainable materials and sustainable energy and water use, or else we will never reach genuinely sustainable development. Awareness of the inherent difficulty to achieve such a result makes many adopted step-by-step processes under the definition of Cleaner Production strategies [1]. If Clean Production is, in principle, the final goal of Cleaner Production strategies and patterns, a stronger effort still needs to be done in order to achieve it. It is not, however, only a problem of time, but also a problem of choosing the right way to get there.

12:10 PM

Self-Interest and System Optimization for Zero Waste: *Susan Kinsella*[1]; [1]Conservatree

Many Zero Waste concepts rely on the functioning of circular systems, which must be completely engaged to operate effectively. A prime example is recycling, which must have high quality processing coupled with collection in order to ensure that materials can best be used for manufacturing. With the surge in global demand for manufactured products, recycling is ever more critical as the foundation for environmentally sustainable production. Any company that sends its waste materials to recycling should ensure they are processed to high quality and should complete the cycle by buying recycled content products. While the recycling system is made up of thousands of independent companies that usually interact with only part of the system, the speaker argues that each company serves its own best interest if it operates for the good of the entire system, and shows the negative results when different parts of the system are neglected.

Challenges and Strategies for Management of Electrical and Electronic Waste in Latin America and the Caribbean Workshop: Challenges and Stategies

Tuesday, 2:00-4:00 PM Room: Miramar 4
October 14, 2008 Location: Hilton Cancun Golf & Beach Resort

Session Chair: Uca Silva, RELAC

Moderated Group Work:

• Group 1:
Moderator: Dr. Carlos Gregorio, Instituto para la Investigación de la Justicia, Montevideo/Uruguay

Challenges and strategies for Governments (Illegal dumping, public education, collection infrastructure, transboundary movements, treatment standards, etc.)

• Group 2:
Moderator:Ricardo Gonzalez Llera, IBM, New York/USA

Challenges and strategies for Industries and Recycling (Organization, system financing, system coverage, historical e-waste, recycling challenges etc.)

• Group 3:
Moderator:Victoria Rudin, ACEPESA, San Jose/Costa Rica

Challenges and strategies for the Civil Society (Bridging the digital divide, consumer behaviour etc.)

• Group 4:
Moderator:Jeremy Gregory, MIT, StEP Initiative –Regional Focal Point for Northern America, Cambridge/USA

Challenges and strategies for Research (Research deficits and needs.)

Presentation and discussions of group work

Challenges and Strategies for Management of Electrical and Electronic Waste in Latin America and the Caribbean Workshop: Future Steps

Tuesday, 4:00-6:00 PM Room: Miramar 4
October 14, 2008 Location: Hilton Cancun Golf & Beach Resort

Session Chair: Jeremy Gregory, Massachusetts Institute of Technology

• Match action items from Module 2 with high-priority challenges

• Prioritize challenges to be addressed

• Assign leaders to create action plans for projects

• Establish regional partnerships to support projects

• Discuss possible coordination and funding strategies for all projects

• Create charter summarizing outcomes from workshop and the path forward

General Recycling and Solid Waste Processing: Composite Materials II

Tuesday PM Room: Caesar 1
October 14, 2008 Location: Hilton Cancun Golf & Beach Resort

Session Chair: Cynthia Belt, Aleris International Inc

2:00 PM Keynote
Influence of Risk Components Contained in Industrial Waste Materials Used in the Building Industry: *Petr Sulovsky*[1]; Miroslav Svoboda[1]; Jaroslava Ledererova[1]; Pavel Leber[1]; [1]Research Institute of Building Materials, JSC.

Essential part at building matters creation have characteristics of raw materials, which have been used for preparation of certain building matters. Industrial waste materials can improve resulting characteristics of new building matter in comparison with classical raw materials. But they can however bring into resulting matter various negative influences, which can manifest in these materials as undesirable, e.g. in unstability and higher variability of required characteristics of these matters depending on time. For each type of secondary raw material, which has to be technologically used, is necessary to make a complete investigation their chemical, physico-chemical, physico-mechanical properties with sight on risk components and risk parameters. Further is necessary to make multilateral technological tests in relation to required characteristics of resulting matters for each select direction of utilization and also to determine limit parameters for criteria, which must given secondary raw material satisfy so it could be used in specific direction.

2:25 PM
Impact Resistance of Polyester Composites Reinforced with Ramie Waste Fibers: *Sergio Monteiro*[1]; Luiz Fernando Santos[1]; Frederico Margem[1]; Felipe Lopes[1]; [1]State University of the Northern Rio de Janeiro - UENF

Continuous and aligned fiber composites provide the highest possible reinforcement for a polymeric matrix. In particular, the impact resistance is significantly increased in comparison with a low energy absorbed brittle polymer. For this reason, investigations have been carried out with both synthetic and natural fibers as a way to improve the toughness of polymeric composites. Among the natural fibers, ramie was not yet been studied for its reinforcement effect to make tougher polyester composites. Thus, the present work assesses the impact toughness of polyester composites incorporated with different amounts of ramie waste fibers.

2:45 PM
Incorporation of Industrial Wastes along with Natural Fiber for the Development of Innovative Building Materials: *Mohini Saxena*[1]; P. Asokan[1]; Ruhi Bux[1]; [1]Advanced Materials and Processes Research Institute

The industrialization has generated and accumulated wastes in alarming proportions with regard to its disposal. Best alternative is to regenerate it for value added products. This study reflects on the potential of re-use of wastes like fly ash, red mud and marble slurry dust for production of wood substitute products like door, windows, roofing sheets and instant houses. Wastes were characterized for physical, chemical and mineralogical properties and applied in different formulations with binder like polymer along with natural fiber jute to intensify the physical and mechanical properties of the resultant composite. Obtained composites have better mechanical properties than the available ones like teak, medium density board, rice husk board etc. Mechanical properties of fly ash and red mud are better than marble slurry dust. The conclusion emphasizes on the use of natural fibres with industrial waste for generation of ecofriendly and non-hazardous composites.

3:05 PM
Laboratory Evaluation of Bituminous Mixtures with Bottom Ash from Municipal Solid Waste Incineration (MSWI): *Marco Pasetto*[1]; Nicola Baldo[1]; [1]University of Padova

The paper discusses the results of a laboratory study, aimed to evaluate the suitability of the bottom ash from Municipal Solid Waste Incineration (MSWI), obtained from different Italian plants, to be recycled in the lithic skeleton of bituminous mixtures, for base layers of road and airport pavements. The research involved a preliminary study of the chemical, physical and geotechnical properties of the bottom ash by itself; it was followed by a mechanical characterization of the bituminous concretes. The traditional Marshall methodology was used to identify the optimum bitumen content; the mixtures were also mechanically checked by means of the indirect tensile strength test, stiffness modulus test, repeated load axial test and fatigue test. Because the requisites for acceptance in the Italian Specifications and Standards have been satisfied and given the positive mechanical performances, it has been verified that the MSWI bottom ash can be used as substitution of the lithic materials in the road bases, also with very high contents (up to 81% on the weight of the aggregate).

3:25 PM Break

General Recycling and Solid Waste Processing: Composite Materials III

Tuesday PM
October 14, 2008
Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Cynthia Belt, Aleris International Inc

4:05 PM Keynote
Recycled Polyethylene Composites Reinforced with Jute Fabric from Post – Used Sackcloth – An Environmentally Correct Building Material: *Sergio Monteiro*[1]; Amanda Lima[1]; Luis Augusto Terrones[1]; [1]State University of the Northern Rio de Janeiro - UENF

Fabric from weaved yarns made of jute fibers have been considered as reinforcement for polymeric composites. In particular, these fabrics obtained from discarded sackcloth are presently being investigated as environmentally friendly composites with recycled polyethylene matrix. The objective of the present work was to compare the practical properties and economical aspects of these composites with those of conventional materials such as wooden board and gypsum panels for building application. The comparison showed that, depending on the amount of post-used jute fabric, a cost/benefit analysis favors these composites over the conventional materials.

4:30 PM
Management of Hazardous Jarosite Waste: Asokan Pappu[1]; *Mohini Saxena*[1]; Shyam Asolekar[1]; [1]Advanced Materials and Processes Research Institute

Jarosite waste released from zinc industries is hazardous in nature and worldwide disposal has become a major concern to safeguard the environment and ecology. In the present study, a process was developed for immobilisation and recycling jarosite waste by developing non hazardous building material. Coal combustion residues (CCRs) as well as marble processing residues (MPRs) was used as additives alongwith clay through solidification/ stabilisation (S/S) and sintering processes. The major mineral phases in jarosite waste are ammonium iron sulphate hydroxide {NH4Fe3 (SO4)2 (OH)6}and Lead sulphate {PbSO4}. The major mineral phases in CCRs are quartz, mullite and hematite. Dolomite is the dominant constituent in MPRs. Results revealed that the optimum mix design of jarosite clay ratio of 1 with 15% CCRs or MPRs obtains intermediate condition to have satisfactory engineering properties in which toxic elements concentration was below the safe limits and deserved to be used in construction applications.

4:50 PM
Nanocomposite Rubber Material with Industrial Waste: *Guillermo Martín-Cortés*[1]; Fabio Esper[1]; Cleide dos Anjos[1]; Hélio Wiebeck[1]; Wildor Hennies[1]; Francisco Valenzuela-Díaz[1]; [1]Polytechnic School of University of São Paullo

Natural rubber reinforced commonly with carbon black to produce vulcanized material, turns into a new environmentally friendly nanocomposite when carbon black is replaced by organically modified clays of Brazil. Carbon black is substance derived from the oil refining process with consequent pollution to the environment. Its substitution in this industrial process must contribute to diminish the oil derived products dependence. As the added clays are only a third in weight of the traditionally carbon black added, then, to obtain the same final volume it is necessary to add low cost neutral filler that does not damage the technological characteristics of the final material. This paper presents results using as neutral filler of this type rice husk ashes and other industrial wastes. Experiences realized with this nanocomposite material show results of quality and technological characteristics similar or superior to those of the rubber made with carbon black.

5:10 PM
Practical Applications for Epoxy Composites Reinforced with Residual Coconut Fibers: *Sergio Monteiro*[1]; Lucas Costa[1]; Felipe Lopes[1]; Helvio Santafe[1]; [1]State University of the Northern Rio de Janeiro - UENF

Residual vegetable fibers as leftovers from crops, industrial activities and consumable items are realistic options to be incorporated into low cost polymeric composites with the aim of replacing other commonly used materials. The present work assesses the technical properties of epoxy composites reinforced with residual fibers from the coconut fruit, also known as coir fibers. Based on these properties, an evaluation was carried out on these coir fiber/epoxy matrix composites to be used as building panels and furniture in comparison with conventional materials.

5:30 PM
Reclamation of Aluminum Matrix from Aluminum Composites Reinforced with Graphite Particles: Petru Moldovan[1]; *Gabriela Popescu*[1]; C. A. Popescu[1]; Aurelian Buzaianu[2]; [1]Polytechnic University of Bucharest; [2]S.C. METAV -Research and Development S.A.

A lot of scraps result in processing of composite materials which contain metallic phases that can be recovered and used again in different field. Considering this point of view the aim of the paper was to separate and recover aluminum from aluminum matrix/graphite composites. The separation and recovery of aluminum alloy from Al alloy/Graphite composite material was done by treatment with halide molten salts. Two types of composite materials were used in experiments: AlSi12CuNiMg/Gr(p) and AlCu4MgTi/Gr(p). As halide salt was used ALUFLUX tablets. After dross separation, the next step was filtration in order to separate the Al matrix from the other impurities and remained dross. Samples from the recovered alloy were analyzed using chem. ical analysis, optical and electron microscopy, as well as X-ray diffraction. The desired composition of the aluminum alloy obtained from scraps could be reached by some addition of metals to the metallic phase.

General Recycling and Solid Waste Processing: Non-Ferrous Metals III

Tuesday PM
October 14, 2008
Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Florian Kongoli, FLOGEN Technologies Inc

2:00 PM Keynote
Process for the Complete Utilization of Oil Sands Fly Ash: *Preston Holloway*[1]; Thomas Etsell[1]; [1]University of Alberta

The fly ash produced by oil sands operations in northern Alberta represents a large, high grade, potential resource for vanadium production in Canada. After extensive batch testing, a conceptual process flowsheet for the recovery

of vanadium from oil sands fly ash was developed. The various unit operations for this process, including decarbonization, roasting, leaching, desilication, precipitation, sodium salt recovery and by-product recovery, are described. Steps for the recovery of molybdenum and HCl, $CaCl_2$ or NH_4Cl from waste streams for this process are proposed as are potential markets for the ash residue as an additive in glass manufacture or in concrete. These by-products represent significant potential sources of secondary revenue while reducing the environmental impact from the process. A preliminary economic analysis for vanadium recovery from oil sands fly ash using this process is included and the economic viability of the process flowsheet presented is discussed.

2:25 PM

Chlorination of Manganese Oxides: Gastón Fouga[1]; *Georgina De Micco*[1]; Ana Bohé[1]; [1]Comisión Nacional de Energía Atómica

The kinetics of the chlorination of manganese oxides, (MnO, Mn3O4 and Mn2O3), has been studied by thermogravimetry between 723 and 1223 K. The chlorination reaction rate was determined by monitoring the mass changes with a high-resolution thermogravimetric system. Non-isothermal and isothermal runs were performed. The chlorination reactions onset temperatures were determined. The influence of gaseous flow rate, sample mass, temperature, and chlorine partial pressure in the reaction rate were analyzed. The solid residue and condensed phases were also analyzed by SEM, EDS and XRD.

2:45 PM

Recovering Heavy Metals from Spent HDP Catalysts: *Zenon Llanos*[1]; [1]Gulf Chemical and Metallurgy Corporation

In the petroleum refining industry, disposal of desulphurization spent catalysts (HDS) has been a concern in the past due to their classification as hazardous wastes. HDS catalysts have higher metal concentrations than regular ores. A recent surge in prices for molybdenum, vanadium, nickel, cobalt and other metals contained in these catalysts is changing the way these materials are viewed by the generators, regulatory agencies and the companies engaged in their treatment and recovery. At the same time the generation of HDS spent catalysts has steadily risen due to new environmental regulations for low sulfur fuels and an increased appetite of gasoline consumers. This paper will examine the evolution in the treatment of spent HDS catalysts and in particular Gulf Chemical and Metallurgical Corporation's sixty years of experience in the in handling and treating HDS spent catalysts.

3:05 PM

Recovery of Nickel from Diluted Solutions by the Combination of Ion Exchange and Successive Electrodeposition: Jeriffa De Clercq[1]; Evelien Vande Steene[1]; *Kim Verbeken*[2]; Marc Verhaege[2]; [1]University College Ghent; [2]Ghent University

The industry is confronted with stricter discharge levels and an increasing awareness to avoid toxic waste (heavy metal containing sludge obtained in physicochemical water treatment) and recover valuable metals. This can be realized by ion exchange and electrodeposition. Both techniques however show an optimum concentration range to efficiently remove and/or recover metals: electrolysis can recover the metal in its metallic form but suffers from low efficiency when applied to diluted solutions, whereas ion exchange can only be applied economically in the low ppm range. A combination of ion exchange followed by electrodeposition was applied to the wastewater of a nickel plating plant. The strong acidic ion exchange resin was stripped with H2SO4 giving a solution of 9g/L nickel. From this solution, nickel was electrodeposited in an ammonia buffer on a Ti-mesh cathode with high current efficiency. It is shown that organic compounds (surfactants, brighteners,…) do not influence the recovery process.

3:25 PM

Recovery of Valuable Metals from Spent Lithium Ion Batteries by Solvent Extraction: *Jingu Kang*[1]; Shun Myung Shin[2]; Jeongsoo Sohn[2]; Donghyo Yang[2]; Sookyung Kim[2]; [1]University of Science and Technology (UST); [2]Korea Institute of Geoscience and Material Resourese (KIGAM)

Cobalt is recovered from square types of spent lithium ion batteries (LIBs) containing 5~20% Co, 5~7% Li, 5~10% Ni, and 7% plastics together with Cu, Al, Fe, and Mn. The leaching test was investigated at 2 M H2SO4, 6 vol.% H2O2, 60°C, 300rpm, 50g/ 500ml, 60min. The leaching efficiency of cobalt was more than 99% and its concentration was 28 g/L. For removing of impurities such as copper, iron, and aluminum in the leaching solution before cobalt solvent extraction, the impurities were eliminated by pH control with NaOH and CaCO3. For selective extraction of cobalt, the aqueous phase removed impurities was equilibrated with different volumes of 0.4M Cyanex 272 saponified of 50%. Extraction efficiency of cobalt was about 80 % at first step. ßCo/Li of cobalt and lithium extractions was 206.5. 9.6% of pure cobalt sulfate solution was obtained after stripping with 2M H2SO4 solution.

3:45 PM Break

General Recycling and Solid Waste Processing: Non-Ferrous Metals IV

Tuesday PM — Room: Caesar 7
October 14, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Florian Kongoli, FLOGEN Technologies Inc

4:05 PM

Sustainable Metals Production and Recycling in Japan: The Present and Issues: *Takahiko Okura*[1]; [1]Akita University

It is said that the energy and resources crisis will come before long because the lifetime of known deposits of crude oil and common metals such as Pb, Zn, Cu is estimated to be less than 50 years. Establishing the sustainable society by means of resources-recycling has become an absolute necessity. The non-ferrous metals industry in Japan has been involved in the resource recycling business for many years, along with the introduction and enforcement of various legislations to preserve the environment and natural resources. Including process-linkage during various manufacturing activities, the industry is treating considerable amounts of recycled materials and wastes in an environmentally-sound and economic manner. The Mining and Materials Processing Institute of Japan has submitted "The present and issues in Japanese non-ferrous metals and recycling industries." The topic of the paper is to highlight the actual conditions within the resources -recycling structures and the present issues.

4:30 PM

Sulfur Reactions in Recycling of Ferrous Scrap: *Ramana Reddy*[1]; [1]University of Alabama

Knowledge of the thermodynamics of basic chemical reactions is essentials in understanding ferrous molten metal refining processes. This information helps to define the possible refining reactions and the limitations of the processes. This presentation includes the thermodynamics of sulfur reactions in ferrous molten metal processing. Our recently developed thermodynamic model (Reddy-Blander model) describing de-sulfurization will be presented. Model calculations of distribution of sulfur in steel and slags will be discussed. The Reddy-Blander model allows a priori calculation of sulfide capacities based on the knowledge of the chemical and solution properties of oxides and sulfide. Importance of the model application to the refining processes in steel industry is emphasized.

4:50 PM

Recycling of Non-Ferrous Metals at Hydrométal, Belgium: *Philippe Henry*[1]; [1]SA Jean-Goldschmidt International

Hydrometal(lurgy) provides an adequate technology to reintroduce otherwise lost metal units into the industrial cycle, thereby saving resources and energy, while keeping the environment cleaner. Two case studies at an integrated hydrometallurgical recycling facility (Hydrométal) in Belgium are discussed. (I) Residual low quality sulfuric acid and caustic soda are used in the processing of zinc industry cements to produce copper, nickel, cobalt and zinc concentrates by several consecutive selective leach - precipitation processes. (II) Copper anode slimes are treated and their precious metal contents are recovered. Depending on the composition of the slimes, separate

or combined concentrates of copper, bismuth, tellurium/selenium and silver/precious metals can be produced.

5:10 PM

Nonmetallic Inclusions in Solar Cell Silicon: Focusing on Recycling of Scraps: *Lifeng Zhang*[1]; [1]Missouri University of Science and Technology

In the current study, removal of SiC and Si3N4 inclusions from top-cut solar cell silicon scraps by filtration with foam filters are experimentally investigated. The fluid flow and inclusion motion in the porous filter are calculated. Possible mechanisms of inclusion removal from silicon through filtration are: 1) Large Si3N4 rods and large SiC inclusions are removed by a cake filtration mechanism at the top of the filter-"cake filtration"; 2) Smaller Si3N4 inclusions and most SiC particles attach directly to the inside walls of the filters - "deep bed filtration"; 3) Large SiC clusters and huge bridges are created around the filter materials; 4) In case of carbon filter, Si dissolves into filter, and/or a new SiC layer is formed by the reaction between silicon and filter material.

5:30 PM

Synthesis of Mn-Zn-Fe Soft Ferrite from Mixed Batteries with Spent Zinc-Carbon Batteries and Spent Alkaline Batteries: *Shun Myung Shin*[1]; Jingu Kang[2]; Donghyo Yang[1]; Taehyun Kim[1]; Jeongsoo Sohn[1]; [1]Korea Institute of Geoscience and Material Resources (KIGAM); [2]University of Science and Technology (UST)

We investigated about synthesis of Mn-Zn ferrite with spinel structure using sulfuric acid leaching solution of mixed spent zinc-carbon batteries and spent alkaline batteries. The waste batteries were prepared by physical treatment such as crushing, magnetic separation, and screening. After screening, the crushed batteries were separated to +8 mesh and -8 mesh powder. The leaching test was investigated at 2 M H2SO4, 4 vol.% H2O2, reaction temperature 60°C, agitation speed 250 rpm, solid/liquid ratio 50 g/500 ml, reaction time 60 min with - 8 mesh powder. The leaching efficiency of zinc, manganese and iron were 99.0%, 98.9%, 58.5%, respectively. For co-precipitation of zinc, manganese and iron, 5M NaOH solution was used for pH control. Then in order to synthesize Mn-Zn ferrite powder, it was investigated according to reaction temperature, agitation speed and O2 partial pressure. We could synthesize about 20 nm of Mn-Zn ferrite with spinel structure.

Separation Technologies and their Energy Efficiency

Tuesday PM — Room: Caesar 4
October 14, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Yongxiang Yang, Delft University of Techology

4:05 PM Keynote

Liberation of a Large Quantitiy of Waste Materials by the Explosion in Water: A Technique with a Relatively Low Energy Consumption: *Toyohisa Fujita*[1]; Kenji Murata[2]; Gjergj Dodbiba[1]; [1]University of Tokyo; [2]Nippon Koki Company, Ltd.

A new crushing technique by means of underwater explosion is put forward. This technique is suitable in crushing and liberating various materials, for instance: the electric parts of the discarded portable telephone, slitting the optical disk (e.g. DVDs), CPU from mother-boards of PCs, steel from plastics tubes used as construction materials, tungsten carbide scraps, waste constructed materials like wood panel, etc. The materials to be crushed are immersed in water and then the explosion in water was carried out by means of a small amount of explosive. The shock waves in combination of the generated bubbles are very effective in liberating the materials of different densities. It was observed that the metals crushed or liberated by using this technique were leached much faster when compared with conventional crushing one. This crushing method can be applied for liberation of many kinds of electric and mechanical tools.

4:30 PM

Metal Recovery and Refining from MSW Incineration Bottom Ash: *Yongxiang Yang*[1]; Yanping Xiao[1]; Liza Balentina[1]; Danny Brouwer[1]; Jack Voncken[1]; Rob Boom[1]; [1]Delft University of Technology

During vitrification of bottom ash generated from the combustion of municipal solid waste (MSW), a Fe-Cu based alloy phase with great value was formed. In order to find proper commercial use in metallurgical industry, it is necessary to separate Cu and Fe. The present study focuses on the sulphide treatment at temperatures of 1400–1500°C, in particular with FeS containing minerals. Various sulphide compounds such as Na2S, Al2S3 and Ni3S2 were added to promote the copper removal. Pyrite and zinc sludge (containing ZnS) as waste streams were studied with specific interests. The results showed that both zinc sludge and pyrite are effective for copper removal with the highest removal efficiency of 95% by using pyrite. The copper content drops from 12 wt% to about 2 wt%. However, it is still difficult to remove copper completely from the alloy in one step, and a multi-step operation is needed.

General Recycling and Solid Waste Processing: Radioactive Waste

Tuesday PM — Room: Caesar 4
October 14, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Yongxiang Yang, Delft University of Technology

4:50 PM Keynote

Treatment of Radioactive Waste Solution Containing Ni, Co and Cs Obtained from the Dissolution of Purification Ionic Exchange Resins of a Nuclear Reactor Primary Cooling System and Its Later Immobilization in a Ferritic Matrix: *Ernesto Esparza*[1]; Silvia Galasso[1]; Maria Castro[1]; Claudia Osuna[1]; Jorge Duca[2]; [1]Atomic Energy National Commission; [2]Nucleoelectrica Argentina S. A.

We present a procedure for treatment of non-active solutions equivalent to the solutions obtained from dissolution of ionic exchange resins used in purification of a nuclear reactor primary cooling system containing Co, Cs and its isotopes as main radioactivity source. Finally it is immobilized into a ferritic matrix by calcination which avoids its future leaching into environment. A bivalent and a trivalent salt is added to solution. Then, either a base or an acid is added, depending on initial pH of the treated solution, with a Cs precipitating additive in order to reduce Co and Cs by precipitation, flocculation and adsorption. Controlling the amount of precipitating reactives it is possible to modify the activity/volume rate becoming a medium into a low radioactivity waste.The leaching test result applied over the ferritic sample is lower than the minimum established by law. Therefore, it can be kept safely in a interim storage.

Training, Education and Social Compatibility of Recycling Systems

Tuesday PM — Room: Caesar 3
October 14, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Rodney Jones, Mintek

2:00 PM Keynote

Training Community for Saving Resources: A Case Study of Eco-Literacy: *V. Jagannatha*[1]; J. Spandana[1]; J. Sadhana[1]; [1]People Science Forum(KRVP)

We are fortunate to be few of the active participants in a voluntary eco-literacy campaign at community level around Kukkarahally Lake, Mysore,

S.India since 2000. In this community endeavor five aims of environmental education (UNEP/UNESCO/IEEP-1977), namely awareness, knowledge, attitude, skill and participation have been attempted. Further, the premise that "A sustainable community safeguards itself while not damaging that of others" (ICUN/UNEP/WWF, 1991) is the agenda. Since 7 years this unique effort has been able to document the existing solid waste management practices in Mysore urban region. It has been possible to observe and list compliance status to Municipal Solid Waste Rules 2000. This rule is the most crucial legal instrument in India where solid waste source segregation, collection, transportation and disposal are now mandatory. It was revealing that good Solid Waste practices are sustained at households, community level at ward no. 37 and Mysore Zoo. However in India over 1,20,000 tons of Municipal Solid Waste everyday gets charged Rs 500 to 1500/ton for sheer clearance. Community means a group of people living together. A sustainable Community uses resources frugally and suitably, recycles materials, minimizes wastes and disposes them safely. A community often fails because of its ecological illiteracy. Ecological Illiteracy is the inability to cognize adverse effects on life, property and comforts on life supports by deliberate or accidental action. Sustainable Development not only meets the needs of the present generation but does not deny the needs of the future generationVarious cultural modes such as street play, folk songs, jatha, and various print medias are used by students and youths in eco-literacy so as to make a big difference. Life Cycle Analysis (LCA) for materials namely Water, Paper, Plastic, Glass and Metal are used to sensitize common man for Conservation at Community level.

2:25 PM

Innovative Technologies of Overcoming of Destructive Factors of the North: *Tsukerman Vyacheslav*[1]; Nikolay Savotkin[2]; [1]Institute for Economic Studies; [2]Technical College

In this work innovative technologies are developed. Their realization promotes strengthening of health of inhabitants of the North due to the decision of the collected environmental problems. Necessity of creation of the Arctic medicine with the purpose of system engineering of measures and effective technologies of overcoming of negative factors and changes of the state strategy of health protection, treatment of chronic illnesses and reduction of influence of harmful manufactures and their waste on health of northerners is shown. Authors executed a complex of the researches directed on reduction of influences of cancerogenic substances and on increase of anticarcinogenic protection of an organism. They are devoted to the group of risk - workersof nickel manufactures of Open Society "Norilsk nickel" (JSC "Norilsk nickel"), located, basically, in regions of the North and described the raised level of oncological desease of respiratory bodies of the workers.

2:45 PM

Optimizing the Material Life Cycle on Campus: The University of Sonora Case Study: *Luis Velazquez*[1]; Nora Munguia[1]; Andrea Zavala[1]; [1]University of Sonora

This presentation will be aimed at describing the evolutive strategy in which the University of Sonora is following for optimizing the organic and inorganic material life cycle in the products used on campus. The University of Sonora is the largest and most important higher education institution among several other universities in both the capital city of Hermosillo and the state of Sonora. Actually, the University of Sonora is seen in its region as an icon of sustainability and it is recognized as a pioneering institution in integrating the principles of Agenda 21 in Regional Sustainability Initiative in Northwest Mexico. The institutional strategy has be oriented towards new patterns of behaviors in order to integrate the principles of sustainability as a guideline for preventing, eliminating, and/or reducing the negative environmental impacts generated when performing university substantive functions of teaching, research, and outreaching and partnership as well as its management operation tasks.

3:05 PM

Recycling, Waste Treatment, and Clean Technology: A Terminological Approach: *Georgeta Rata*[1]; Cornelia Petroman[1]; Ioan Petroman[1]; [1]Banat University of Agricultural Sciences and Veterinary Medicine Timisoara

Proper training and education in the field of recycling and waste treatment are inconceivable without the proper teaching of the terminology specific to both recycling (aerospace products recycling, automotive recycling, general recycling, recycling behavior, recycling schemes, recycling systems, and waste recycling) and waste (characterization of waste, electronic waste, heavy-metal containing waste, monitoring of waste, radioactive waste, solid waste, waste collection, waste conversion, waste recycling, waste reutilization, waste stabilization, waste storage, and waste treatment) in both the students' mother tongue and in English for Special Purposes (ESP) as a second language (with focus on the structuring of the specific terminology). Including linguistic approaches among the possible approaches of environmental protection and material sustainability means including linguistics among the various disciplines addressing energy supply, cement and building materials, metallurgy, chemistry, glassware, pulp and paper industry, machinery, automobile and electronic industries, collection, and sorting, further treatment and final disposal of post-consumer material.

3:25 PM

Training for Women Self Help Groups on the Production of Live Foods for Ornamental Fish Culture through Recycling of Agricultural and Animal Wastes: *R. Santhakumar*[1]; N.V. Sujathkumar[1]; I. Vasudhaven[1]; [1]Fisheries College and Research Institute, Tamilnadu Veterinary and Animal Sciences University

Freshwater ornamental fish culture is gaining importance in India and cheaper and nutrient rich live foods such as infusoria, Daphnids, Copepoids and Tubifacids are needed urgently. In this regard adequate research has been conducted to produce such live feeds through recycling of agriculture and animal wastes. During this venture besides generation of additional income, environment is also kept clean. In order to popularise the technologies relating to production of live foods from wastes and generate employment opportunities, training programmes are conducted for 100 Self Help Group women belonging to Thoothukudi district. The topics of the training included, breeding of ornamental fishes by utilizing the building material wastes, production of live foods through recycling of agricultural and animal wastes. A study on feed back was conducted with 100 respondents represented from different villages. Variables such as socio economic status, economic motivation, usefulness of training and constraints were included in this study. The impact assessment of this training of rural women indicated that 81 percent respondents were in favour of using the training for self employment by utilizing different kinds of wastes. Similar training have also been planned in other parts of Tamilnadu.

3:45 PM Break

Resource Statistics, Material Flow Analysis, Information Systems

Tuesday PM
October 14, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Rodney Jones, Mintek

4:05 PM Keynote

Improving the Efficiency of Recycling Processes through On-Line Control, Optimization and Automation: *Florian Kongoli*[1]; I. McBow[1]; E. O'Brien[1]; S. Llubani[1]; [1]FLOGEN Technologies, Inc.

Recycling processes are generally associated with a higher degree of complexity compared to classic extraction processes. The physics and the chemistry of these processes are much more complicated. The feed materials come from various sources and are characterized by considerable fluctuations in chemical and physical characteristics. These factors as well as

other numerous ones make particularly challenging these recycling processes and, as a result, indispensable their proper control and optimization in order to improve their efficiency. In this work an original approach for the control and optimization of these processes has been exposed. This not only allows a continuous on-line control and optimization but at the same time can serve as an adequate means of automation of any specific process. The advantages of this new approach have also been discussed.

4:30 PM

Addressing Impurity Accumulation: A Simple Model of Limiting Recycled Fraction: *Elsa Olivetti*[1]; Gabrielle Gaustad[1]; Frank Field[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology

The primary challenge to increased use of secondary raw materials is the presence of undesirable elemental species in scrap streams. Recent literature indicates that this accumulation of elemental impurities is increasingly problematic. Devising strategies to mitigate this problem depends upon understanding the mechanisms of accumulation. Traditional analyzes of scrap flows have relied upon market-wide statistical metrics that tend to mask fine technical structures, which might offer desired insights into the management of compositional drift. An analysis of aluminum streams that takes this technical, rather than statistical, approach will be presented, focusing upon largely transportation and packaging scrap patterns typical for the North American aluminum market. This work explores simulation methods for long term aluminum material flows, including the impact of different technical approaches to the mixing of incoming scrap streams.

4:50 PM

Modern E-Commerce Technologies and Computerised Information Systems for Material Flow Management and Analysis: Buddhika Bandara[1]; *Sarath Gunathilaka*[2]; [1]IDM Computer Studies (Pvt) Ltd (From January 2008, Nottingham Trent International College); [2]Nottinghamshire County Council

Among the resource requirements for manufacturing, materials are prominent. Both material delay and excess stocks make losses. Therefore, correct statistics and information on material flow are essential in production lines. Material flow analysis is crucial because the entire productivity depends on the availability of materials on time. It is a part of the production planning. Managing materials manually is difficult in continuous production flows and therefore, automated systems are needed. There are various types of computerised systems used today. On the other hand, E-commerce made a great change for smoothing material flow transactions between manufacturers and suppliers. Computerised Inventory Control systems help to identify statistics on recycling materials. This paper describes the modern computerised material management systems and E-commerce technologies. It discusses about their advantages, disadvantages and effect for recycling and enhancing productivity. Finally, it concludes that they are the most productive applications for Material flow management and analysis.

5:10 PM

Substance Flow Analysis of Zinc in China: *Guo Xueyi*[1]; Song Yu[1]; Wang Yong[1]; Tian Qinghua[1]; [1]Central South University

The flow of zinc in China, 2004, was traced within the STAF model, and the situation of production, consumption and recycling of zinc resources in China were introduced. The SFA is performed on zinc flows during its one year life cycle in detail, and the resource efficiency of China was compared with that of European countries. The result reveals that China produces and utilizes a large amount of zinc, while the resource efficiency of zinc is much lower than that of the developed countries. As one of the biggest producer and consumer of zinc in the world, China is facing a severe depletion of zinc resources. How to increase the resource efficiency is a significant issue for zinc industry of China. Based on the result, several advices were proposed in the paper, aiming to contribute important reference information for the resource management and recycling of zinc industry in China.

Treatment of Liquid and Gaseous Effluents II

Tuesday PM
October 14, 2008

Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Florian Aurelian, Research and Development National Institute for Metals and Radioactive Resources

2:00 PM Keynote

The Electrolytic Recovery of Silver from Photographic Fixing Baths: *Carla Lupi*[1]; Mauro Pasquali[1]; [1]University of Roma La Sapienza

Photographic technology is based on light sensitivity of silver halides that, because of silver properties, are capable of forming photographic images. Photographic laboratories and hospital departments because of digital photographic systems less use this technology today. Nevertheless recovery of silver is still advantageous because environmental problems related to Ag ions danger to biological system. Many processes have been studied to treat silver containing photographic bath: cementation, chemical precipitation and electrowinning. In this work, after preliminary voltammetric tests, a batch electrometallurgical process has been studied. The effect, on process yield and deposit quality, of silver concentration in the electrolyte, varying over the range 3-10 g/L, bath stirring, current density ranging from 10 to 200 A/m2 has been investigated.

2:25 PM

Mine Waters Decontamination Using Geochemical Barriers: *Florian Aurelian*[1]; Mihai Popescu[1]; [1]Research and Development National Institute for Metals and Radioactive Resources

The paper presents the results concerning the performances of some "geochemical barriers" used for the decontamination of mine waters from uranium mining sites. Three types of "geochemical barriers" were used as follows: mixture of pit coal, sawdust and zeolite; mixture of bentonite, sand, wood chips and pit coal; mixture of iron span, sand and wood chips. All those mixtures were contacted with mine waters containing uranium, radium and heavy metals. The uptake capacity was determined for each one of the mixtures. The optimum mixture was determined and its efficiency was tested within an uranium areal, where the activity was stopped. It was determined the possibility to recover the radioactive elements and the heavy metals from the investigated barriers. In order to accomplish the environment protection practical solution for the implementation of the "geochemical barriers" on sites, where the mining workings are in progress, closed and in ecological reconstruction were elaborated.

2:45 PM

Adsorptions of Copper from Aqueous Solutions by Modified Orange Peel Biosorbent: *Guo Xueyi*[1]; Feng Ningchuan[1]; Liang Sha[1]; Tian Qinghua[1]; [1]Central South University

A biosorbent, the chemically modified orange peel ,was synthesized from hydrolysis of the grafted copolymer, which was originated from reaction of methyl acrylate with cross-linking orange peel. The biosorbent was characterized using infrared spectroscopy. The adsorption characteristics and the effects of various factors of the biosorbent on adsorption of Pb(II) were discussed including pH, adsorption time and initial concentration of Pb(II). Experimental results show that when pH was 5.6 and the initial concentration of Pb(II) was 50mg/L, the removal rate was 93.73% and adsorption capability was 25.53 mg/g after 3 h adsorption. After five cycle, 85% removal rate could be obtained by the biosorbent.

3:05 PM Break

Treatment of Liquid and Gaseous Effluents III

Tuesday PM
October 14, 2008

Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Ange Nzihou, Ecole des Mines d'Albi-Carmaux

4:05 PM Keynote
Up to Date Technologies for off-Gas Cleaning: *Petr Stehlik*[1]; Radek Dvorak[1]; Ladislav Bebar[1]; Tomas Parizek[1]; [1]Brno University of Technology

More and more sweeping environmental regulations initiate research, development and introducing into operation up to date technologies for cleaning off-gas and flue gas generated in various branches of the industry and municipal waste treatment. The following systems based on novel types of equipment are shown: thermal and catalytic treatment of waste gases polluted by VOC and carbon monoxide (alternatively NOX), catalytic filtration for efficient destruction of PCDD/F (dioxins) and potentially NOx, wet cleaning of flue gases polluted by SO2, HCl and HF with a original type of homogenizer "O-element", integrated equipment for cleaning waste gases polluted by solid particulates, SO2, HCl, HF and heavy metals (alternatively NOX or PCDD/F). The outstanding features of all equipment mentioned above are low investment and operating costs together with high removing efficiency of pollutants. These units can be used mainly in incineration plants, refineries and other chemical plants.

4:30 PM
Treatment of Liquids and Sludge Using Electro Plasma Technology: *Pratheesh George*[1]; Danila Ryabkov[1]; Greg Tenhundfeld[1]; Edward Daigle[1]; [1]CAP Technologies LLC

Electro Plasma Technology which is used for cleaning, coating and surface modification of metals can be also used for the treatment of liquids and sludge to remove contaminants such as metals, oils, organics and other harmful elements to the environment. This technology employs a cathode, an anode and electric supply and the liquid to be treated is introduced into the gap between the anode and cathode to be exposed to an electro plasma field which has aspects of ultraviolet blue light, thermal energy, cavitation, flocculation, aeration and electrical energy. Non-metals are mineralized and metals are plated to the cathode to be removed from the liquid. The ability to control flow rates, energy density, cavitation density, aeration density and heat generation offers a new level of control over different materials during treatment.

4:50 PM
Usage of Calcium Phosphate Sorbent for the Removal of Heavy Metals from Industrial Flue Gas - Investigation at Pilot Scale: Cédric Verwilghen[1]; *Ange Nzihou*[1]; Daniel Gauthier[2]; Patrick Sharrock[3]; Gilles Flamant[2]; Guy Depelsenaire[4]; [1]Ecole des Mines d'Albi-Carmaux; [2]Procedes, Materiaux et Energie Solaire-Cetre National de la Recherche Scientifique; [3]Université Paul Sabatier; [4]Solvay

This study examines the vaporization and partitioning of heavy metals during the incineration of various industrial wastes, and the efficiency of sorbents for the removal of these metallic compounds in industrial flue gas. The investigation were carried out at laboratory and pilot scale. Metal vaporization kinetics and behavior were determined during the incineration under various conditions. The behavior of the selected heavy metals and their removal with standard industrial sorbents such as sodium bicarbonate (NaHCO3), lime (Ca(OH)2) and activated carbon were also investigated in a pilot solid waste incinerator. A new sorbent based on calcium phosphate called hydroxyapatite, was used during the smoke treatment. The results at both laboratory and pilot scales showed that the use of this sorbent improve significantly the removal of heavy metals. The pilot scale experiments confirm that heavy metals are concentrated in fly ashes and cyclone residues, thus effectively reduced their release to the atmosphere.

Waste Conversion and Reutilization III

Tuesday PM
October 14, 2008

Room: Caesar 6
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Ivanildo Hespanhol, University of São Paulo

2:00 PM Keynote
Production of Structural Products from Copper Mining Tailings: *Thomas Claridge*[1]; Thomas Weyand[2]; Dale Nickels[2]; [1]Freeport McMoRan; [2]Pittsburgh Mineral and Environment Technologies Inc.

This paper addresses the results of a project to evaluate the suitability of copper mining tailings as raw material for the production of structural products using PMET's patented technology. The mineralogy of the mill tailings was characterized by quantitative x-ray diffraction as well as size distribution, moisture etc. Preliminary testing indicated that high performance structural products were possible using these materials. A demonstration scale project produced approximately 1,500 bricks in various colors. These products fall under ASTM C-73 and were found to present properties suitable for severe weather applications. Although the products in this project were of brick sizes, other products are also possible, for example concrete block substitutes, or pavers. This paper will provide operational details of the production process, mineralogy and mechanical properties of the products and an economic analysis of the capital and operating costs for a plant capable of producing 10 million bricks per year.

2:25 PM
Old Copper Flotation Tailings Reprocessing and Sustainability: *Zoran Markovic*[1]; [1]University of Belgrade

Exploitation of copper ore in Bor, Serbia, has over hundred years long history. During this period mining wastes (mining and flotation tailings) were formed with about 650 Mt solid materials, which, by geology estimation contains about 750.000 t of metal copper. All these wastes have a negative environment impact, but utmost have flotation tailings. The tailings consists of very fine dust, contaminated water, also very fine material leaking out from tailing pond in nearby rivers in the one hand and valuable compounds such as Cu, Ag, Au on the other hand. The average contents of copper is 0.3%, gold 0.8 g/t, silver 2.4 g/t and sulfur 12.7%. Old Bor flotation tailings is located near to Bor city center and because of that as a main objective is provide recycling and delaying process of flotation tailing on location where will be no environment impact followed by sustainability. Reprocessing of flotation tailings by recycling process will be obtained metal copper and other valuable compounds and also opportunity for self financing cleaning of Bor creek trough.

2:45 PM
Pre-Washing and Vitrification of Fly Ash from a Municipal Solid Waste Incinerator: *Yanping Xiao*[1]; Robert Harskamp[1]; Yongxiang Yang[1]; [1]Delft University of Technology

Stricter environmental regulations demand for a safer treatment for the disposal of incineration fly ashes. New processes and technology need to be developed for comprehensive utilization and detoxification of the MSWI residues. The objective of the current research is to better understand the behaviour of the environmental harmful elements, and to find an optimum route for an efficient processing of the incineration fly ash. In the present study, the fly ashes sampled from a MSWI were washed with warm water, and the residues were dried and sintered or vitrified at high temperatures. The solutions from ash washing and the ash residues before and after thermal treatment were analysed. The results of vitrification and thermal behaviour were compared with those from the ashes without pre-washing. It was found that water pre-washing is an efficient way to remove volatile salts, and thus the secondary emissions during vitrification could be reduced.

3:05 PM

Recycling of Rice Residues for Bioenergy: Case Studies in Rural Philippines: *Jose Nicolas*[1]; [1]Red Foundation

The study documented the use of rice residues (i.e. rice hull, rice straw) as source of renewable energy for domestic cooking and energizing small industry. The abundance of rice hull in the countryside stirred the imagination of some entrepreneurs to develop rice hull stove of various sizes and designs. Its commercialization created a demand in the use of rice hull materials. On the other hand, the demand for rice straw as fuel for drying clay products (pots, bricks) also gained recognition among clay product makers. The reasons cited in using rice residues as fuel were: high cost of fossil fuels, scarcity of firewood and abundance of rice residues. Cognizant of the energy and environmental problems, various GO's and NGÓ's developed technologies that would utilize rice residues more efficiently. Some of these technologies include: improved rice hull stove, rice hull charcoal briquette, pyrolyzer for irrigation, crop/grain drier, and bakery oven.

3:25 PM Break

Waste Conversion and Reutilization IV

Tuesday PM Room: Caesar 6
October 14, 2008 Location: Hilton Cancun Golf & Beach Resort

Session Chair: Ivanildo Hespanhol, University of São Paulo

4:05 PM Keynote

Spent Potliner Management in Aluminium Industry: *Jose Concha*[1]; André Bastos Cardoso[2]; Francisco José Moura[1]; [1]Catholic University of Rio de Janeiro; [2]Valesul Alumínio S.A.

Spent potliner (SPL) is an aluminium industry hazardous waste. SPL is formed by two fractions: Carbon and refractory materials. The main objective of this work is to develop new methods to improve spent potliner management associated with physical chemical characterizations which can lead to evaluate new applications of SPL. The carbon fraction was evaluated as being a material with high calorific value (16 MJ/kg), this will be used as substitute combustible in combustion process. Refractory fraction is composed by alumina (with high fluoride value), SiC bricks (these are recycled to build a new electrolytic cell or are sold) and refractory bricks (which are sold to ceramic industry). Alumina and electrolytic bath are crushed and recycled as a raw material to reduction process. Spent potliner remaining contains less fluorides compounds, and it can be co-processed in a high rate in the cement industries.

4:30 PM

Reuse of Waste Paper Sludge as Supplementary Cementing Material: Moisés Frías[1]; M. Isabel Sánchez de Rojas[1]; Olga Rodríguez[1]; *Iñigo Vegas*[2]; Rosario García[3]; Raquel Vigil[3]; [1]Eduardo Torroja Institute; [2]Fundación Labeín; [3]Universidad Autónoma de Madrid

The paper shows the reutilization of a paper sludge waste as supplementary cementing material for the cement manufacture. This starting waste by their characteristics is an inert and non pozzolanic material but once activated under controlled thermal conditions present good qualities as active addition. This research work presents the scientific and technical viability of recycling these paper sludge wastes in order to obtain recycled metakaolin with the consequent environmental, economic and energetic benefits. The physical and mechanical results obtained in blended cement matrixes with different percentages of recycled metakaolin showed good behaviours of novel blended cements, even an improvement of these properties with respect to the control matrix. This research work has been funded through a Research project (CTM2006-12551-C03) of the Spanish Ministry of Education and Science.

4:50 PM

Waste Conversion and Reutilization: Wastewater from Pig-Farms: *Cornelia Petroman*[1]; Ioan Petroman[1]; Horia Sarandan[1]; Nicolae Pacala[1]; [1]University of Agronomic Sciences and Veterinary Medicine Bucarest

Disposing wastewater from pig-farms directly into watercourses (especially where the main target of production schemes is to observe production schedules) can have a negative impact on the environment (disturbance of the aquatic flora and fauna, health problems in humans, etc.). This can be avoided nowadays due to compulsory environmental licences that ask for the treatment of wastewaters with a view to minimize their impact on the environment (recovery of the eco-system through the establishment of a proper ecological balance) and to increase agricultural production through the use of wastewater (directly or after storage) in irrigations (CBO5 40 mg/l, CCO 98 mg/l, pH = 7.0, and O2 8-10 mg/l) and of rough materials as natural fertilisers (after composting solid shares and decantation sludge for at least half a year). In many cases, they need to improve the functioning of already existing water-plants built up on pig-farms.

5:10 PM

Water Reuse for Irrigation – Can Developing Countries Afford a Tolerable Disease Burden of No More than 10-6 Disability-Adjusted Life Years (DALY) per Person per Year (PPPY)?: *Ivanildo Hespanhol*[1]; [1]University of São Paulo

DALYs are calculated as the sum of years of life lost by premature mortality (YLL) and years of healthy life lost in state of disability (YDL), which are standardized by means of severity weights, thus: DALY=YLL+YLD. WHO has established for wastewater use in irrigation (WHO, 2006) the same reference level of health protection as established for drinking water quality (WHO, 2004), i.e., the additional burden of disease from consuming water irrigated food should not exceed 10-6 DALY(Disability-Adjusted Life Years) loss per person per year (pppy). Such a restrictive risk is almost impossible to be attained in most developing countries which may not be able to afford the associated costs,even for restrict irrigation. This paper presents proposals to adapt the reference level of risk to local conditions of developing countries on the basis of a risk benefit approach.

Wednesday Plenary Session

Wednesday AM
October 15, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Brajendra Mishra, Colorado School of Mines

9:00 AM Plenary
Moving Business to Clean Production and the Triple Bottom Line: *J. Michael Huls*[1]; [1]California Take It Back Partnership

The scope of this presentation is to present state of the art in clean production, which is defined as a diverse range of products, services, and processes that: •Harness renewable materials and energy sources; •Dramatically reduce the use of natural resources and restores the ecology; and •Reduce or eliminate emissions and wastes. We also know it as zero wasting, waste minimization, and pollution prevention, but at its heart, it is about valuing our resources at all stages and steps of consumption. Topics to be covered in detail and case study include: •Intro to Clean Production in California; •Policies, Plans & Practices; •Economics and Case Studies; and •Education and Total Participation.

9:30 AM Plenary
E-Waste Recycling - A Relevant Contribution to Closing Global Material Cycles: *Heinz Böni*[1]; [1]EMPA

The global production of electronic devices and particularly of Information and Communication Technologies (ICT) faces the biggest industrial expansion of the history. Independent of the country development status Waste from Electrical and Electronical Equipment (WEEE or e-waste) has turned into the fastest growing waste component worldwide. Many of the particularly metal resources are more and more shifting its presence from the natural environment into the anthroposphere. Obsolete equipments and materials become new resources and hence recovering of these valuable resources is more and more becoming a global concern. Limits for recovery lie in many aspects along the whole life cycle: on the side of the product the high dissipation and complexity of the products and on the side of waste in the insufficient recollection and often inadequate recycling technologies. Future solutions need international cooperation of all private and public actors. This plenary presentation gives an overview on the global relevance of metal recovery from e-waste and the mayor challenges and approaches in increasing a resource efficient recovery.

10:00 AM Break

Case Studies in the Development of Waste Treatment Technologies III

Wednesday AM
October 15, 2008

Room: Caesar 8
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Luis Sobral, Centre for Mineral Technology-CETEM

10:30 AM Keynote
Pelletization of Slag from Steel Desulfurization: *S. Komar Kawatra*[1]; [1]Michigan Technological University

A typical steelmaking facility produced 50,000 tons per year of slag in their hot-metal desulfurization process. This slag had a sufficiently high iron content that it could be beneficiated and recycled in a blast furnace, provided that the slag could be agglomerated into pellets suitable for use as blast furnace feed. In this work, beneficiated slag was agglomerated using both a conventional bentonite binder, and a fly-ash-based binder (FBB) that was formulated by the investigators. The FBB consisted of a combination of high-carbon fly ash with calcium hydroxide activator, allowing the FBB to exhibit binding properties when moistened. It was determined that beneficiated slag agglomerated with FBB had superior compressive strengths compared to slag agglomerated with conventional bentonite binder. Since the fly-ash component of the FBB is commonly discarded as waste, this approach also provides a means for utilizing high-carbon fly-ashes that currently have very little commercial value.

10:55 AM
Old Copper Flotation Tailings Reprocessing and Sustainability: *Zoran Markovic*[1]; [1]University of Belgrade

Old flotation tailings consists of very fine dust, contaminated water, also very fine material leaking out from tailing pond in nearby rivers in the one hand and valuable compounds such as Cu, Ag, Au on the other hand. The average contents of copper is 0.3%, gold 0.8 g/t, silver 2.4 g/t and sulfur 12.7%. The flotation tailings is located near to Bor city center and has great environmental impact. Reprocessing of tailings materials offers an economical opportunity for obtaining valuable compounds followed by sustainability. Paper presents results from extending laboratory work for recovery of above mentioned compounds, for example copper recovery in bulk concentrate was achieved up to 98%. Attrition technique is applied, rather than regrinding, in mineral liberation and cleaning of their surfaces prior to flotation. Attrition is much more cheaper than grinding, and provides better results in flotation, too.

11:15 AM
Physical, Mechanical and Durability Study of Dunes Sand Mortar in the Region of Laghouat: *Azzouz Lakhdar*[1]; Benabed Benchaa[1]; Belaidi Akram Salah Eddine[1]; [1]University of Laghouat

The main objective of our work is to exploit a largely available material in the Algerian south which is the dunes sand, as a material of construction in the region of Laghouat. In this study. First we investigated the effect of the curing environment and the nature of the sand on the mechanical properties of the mortar, such as; flexural and compressive strengths. Then after, we studied the durability of the mortar under cycles of wetting- drying and the chemical attack of sodium sulfate (Na2SO4 5%). According to the results, we note that the mortar of the sand mixes (river sand plus dunes sand) present the best mechanical performances, under different environment of curing. In addition, result of the durability studies put forward that the mortar of the sand mixes is more resistant to the sulfates attack.

11:35 AM
The Application of ViroMine™ Technology to Intractable Mine Waste: Global Treatment Outcomes: *Lee Fergusson*[1]; [1]Virotec Europe Limited

This paper will introduce the primary features of ViroMine Technology and its application to mine site remediation and the treatment of a variety of intractable wastestreams, including a technical discussion of acid neutralising capacity, metals binding capacity, and long-term stability of results. Outcomes from four applications at high-profile international mine sites will be presented: 1) the superfund site at the Gilt Edge Mine, South Dakota, USA (five-year data on the treatment of high acidity, TDS, and metals such as Al, Co, Fe, Mn and Zn); 2) Australia's most polluted site at the King River Delta in Australia (treatment of TAA and TPA, and heavy metals such as As, Cr and Hg); 3) the Aljustrel "Aqua Forte" mine site in Portugal (high acidity and heavy metals such as Al, As, Cu and Zn); and 4) the Ulsan Iron Ore Mine at Ulsan, South Korea (treatment of heavy metals such as As, Cd and Ni).

11:55 AM
Stabilization of EAF Slag for Use as Construction Materials: *Qixing Yang*[1]; Björn Haase[2]; Fredrik Engström[1]; Anita Wedholm[1]; [1]Luleå University of Technology; [2]Höganäs AB

MiMeR started industry related research work to stabilize the EAF slag with values of CaO/SiO2 for the slag ranging from 2.5 to 3.5. It would be possible to use the EAF slag as construction materials after the stabilization. Some of the agents effective for preventing disintegration of AOD slag were examined in laboratory tests for stabilization of the EAF slag. Test mixtures, the slag samples mixed together with stabilizing agents, were melted at 1530-1640ºC and then cooled in crucible system. With a laboratory granulation system the liquid EAF slag was cooled rapidly using air. Samples of the test

mixtures and slag granules were characterized, including SEM and XRD analyses. Some of the results from the work may be useful for preventing the slag disintegration and, thus, enhancing utilizations of the EAF slag to save valuable natural resources.

Case Studies in the Development of Waste Treatment Technologies IV

Wednesday AM
October 15, 2008

Room: Miramar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Lourdes Yurramendi, INASMET-Tecnalia

10:30 AM Keynote
The Roles of Reactor Geometry, Polyphenols, and Lignin in Vermicomposting: Sankar Ganesh[1]; Gajalakshmi S.[1]; *S. Abbasi*[1]; [1]Pondicherry University

Vermicomposting of the pre-composted leaf litter of acacia (Acacia auriculiformis) was studied by different densities of the earthworm Endrilus eugeniae and Lampito mauritii in reactors of identical volume but with surface area:height ratios varying from 4 to 250. The results reveal that greater the surface area:volume ratio of the reactor, higher is the vermicast output; in terms of vermicast output per animal, the more densely populated reactors were comparatively under-productive. Though the vermicast production remained consistently high in all the reactors, there was significant earthworm mortality throughout the course of the experiments. The worms who survived steadily lost weight. As these observations were in contrast with our earlier findings with several different substrates, a detailed investigation of the possible causes was carried out. It revealed that whereas the C:N ratio of acacia compost was comparable with that of other substrates; the polyphenols and lignin content were much higher.

10:55 AM
Uses of Fly Ash to Eliminate Copper from Waste Cyanide Mine Waters: Julia Ayala[1]; José Martínez[1]; Purificación Coque[1]; *Begoña Fernández*[1]; [1]Universidad de Oviedo

The objective of this study was to examine the suitability of using adsorption with a coal residue, fly ash, to remove the copper cyanide species from gold mine effluents. In order to discharge them safely with minimum impact to the environment the effluents must be treated in such a way that the legal conditions were attained with the lowest possible cost. This paper presents the treatment of cyanide solution originating from tailing ponds at the end of the detoxification by direct contact with two differents flying ashes. The results obtained in the experiments carried out show the effectivity of ashes in the adsorption of metallic cyanide complex and especially in copper ones.

11:15 AM
Vermicomposting of the Leaf Litter of Acacia (Acacia Auriculiformis): Possible Roles of Reactor Geometry, Polyphenols, and Lignin: P. Sankar Ganesh[1]; Gajalakshmi S.[1]; *S. Abbasi*[1]; [1]Pondicherry University

Vermicomposting of the pre-composted leaf litter of acacia (Acacia auriculiformis) was studied in reactors of identical volume but with surface area: height ratios varying from 4 to 250. In separate sets of experiments with these reactors, epigeic earthworm species Eudrilus eugeniae and anecic earthworm species Lampito mauritii were employed at densities of 75 and 150 adult animals per litre of reactor volume. The results reveal that greater the surface area: volume ratio of the reactor, higher is the vermicast output; the shallowest reactors (2 cm high) produced about 30% higher vermicast than the deepest ones (16 cm high). The vermicast output in reactors of higher earthworm density was expectedly higher than the output from the reactors with lesser earthworm density but the difference was only marginal. In terms of vermicast output per animal, the more densely populated reactors were comparatively under-productive. Even as the vermicast production remained consistently high in all the reactors, there was significant earthworm mortality throughout the course of the experiments and the worms who survived, steadily lost weight with time. As these observations were in contrast with our earlier findings with several different substrates, a detailed investigation of the possible causes was carried out. It revealed that whereas the C: N ratio of acacia compost was comparable with that of other substrates; the polyphenols and lignin content were much higher. It is known that leaf litter in the forests which is rich in polyphenols and lignin is not preferred by most species of earthworm. This may perhaps be the reason for the high rate of mortality and weight loss in earthworms forced to feed upon acacia in the experiments conducted by us.

11:35 AM
Vitrification by Plasma Treatment, an Environmentally Sound Technology for APC Residues: *Lourdes Yurramendi*[1]; Juan Carlos Múgica[1]; Javier Antoñanzas[1]; Jorge Aragón[1]; Susana Caballero[1]; [1]INASMET-Tecnalia

Air Pollution Control (APC) residues treatment by plasma technology was studied as a case study in the context of TESTNET (Towards European Sectorial Testing Networks for Environmental Technologies) project, supported by the European Commission in the sixth framework programme. During the project a protocol to verify the plasma technology was developed. The protocol was afterwards applied to a specific case study: the APC residues from Municipal Solid Waste Incinerators (MSWI). Different operational conditions were tested and the vitrified products obtained analyzed using standardized leaching tests in order to evaluate their new properties concerning safety storage. Two leaching tests were used for the evaluation, the European EN 12457-4 compliance test for leaching of granular waste materials and the French XP X 31-211 test for the determination of the leachability of a solid waste material initially massive or generated by a solidification process.

11:55 AM
Waste Processing – Latest Achievements: *Petr Stehlik*[1]; [1]Brno University of Technology

This paper is aimed at showing and demonstrating progress in technologies and improvements in units for the thermal processing of various types of waste. It represents a challenge for potential investors and operators as well as researchers. Case studies presented cover several important fields and are based on research and development using experimental facilities, sophisticated approach (including CFD), and feedback from industrial operation. The following areas are covered: units for the thermal treatment of hazardous industrial wastes and common MSW, technologies for the thermal treatment of industrial and sewage sludge, utilizing wastes in cement production (material and energy recovery), up-to-date off-gas cleaning systems, original and unique units for the thermal processing of polluted gases, low-NOx burners. The paper represents a review based on industrial applications, papers published in reputable international journals and a monograph under preparation.

Clean Technology and Reengineering of Current Processes III

Wednesday AM
October 15, 2008

Room: Caesar 5
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Jose Parga, Institute Technology of Saltillo, Department of Metallurgy and Materials Science

10:30 AM Keynote
The Alkaline Sulfide Hydrometallurgical Separation, Recovery and Fixation of Tin, Arsenic, Antimony, Mercury and Gold: *Corby Anderson*[1]; Larry Twidwell[1]; [1]Montana Tech-University of Montana

Throughout the world, there are many orebodies or materials which have significant value but also contain arsenic, antimony, and mercury. Many of these are wastes or by products from primary processing. As regulations on the transport, exposure, disposition and emission of these elements have become more stringent; it has become increasingly more difficult to derive the values

from the resources. This paper outlines the fundamentals of alkaline sulfide hydrometallurgy and its successful application to arsenic, antimony, tin, gold and mercury bearing ores, concentrates, by-products, and other materials.

10:55 AM

The Advantage of CTAB(Cetyl-Three-Ethyl-Ammonium Bromide) Use on the Electroleaching of Copper Sulphides Flotation Concentrate: *Luis Sobral*[1]; Vania Mori[1]; Marcos Aguiar[1]; [1]Centre for Mineral Technology-CETEM

This paper presents a low-cost operational electroleaching process for treating copper sulphides flotation concentrates, with a high chalcopyrite content. This research practical work aims at improving the copper extraction from that sulphide mineral, in a relatively short time with low-operating cost taking into consideration the influence of a cationic surfactant. The electrolyte of the electrolytic reaction system was a 2mol.L-1 NaCl solution containing CTAB, a cationic surfactant. The electroleaching system contains one DSATM (dimensionally stable anode) anode and two nickel or copper foams (three-dimension electrodes. During the electroleaching process the chloride ions are oxidized to chlorine at the anode surface, which in contact with the aqueous phase generate enough hypochlorite ions to oxidize chalcopyrite. The copper ions released from the chemical oxidation process are reduced at the cathode surface as metallic copper.

11:15 AM

A Thermodynamic Study of Arsenic Adsorption onto Iron Species Generated by Electrocoagulation: *Jose Parga*[1]; Alhondra de los Santos[1]; Jesús Valenzuela[2]; [1]Institute Technology of Saltillo, Department of Metallurgy and Materials Science; [2]University of Sonora, Department of Chemistry

The present study evaluated the feasibility of using iron species generated by electrocoagulation (EC) as an adsorbent for removal As(III/As(V) from aqueous media. The full potential of EC was evident in that more than 99 percent of arsenic was removed without addition of chemical reagents. The adsorbent iron-species generated by EC was characterized by Chemical Analyses, X-Ray Diffraction and Scanning Electron Microscopy. The experimental data were correlated by employing a Langmuir adsorption isotherm. Thermodynamic parameters such as $\Delta H°$, $\Delta S°$ and $\Delta G°$ were calculated. The adsorption process was found to be exothermic and spontaneous.

General Recycling and Solid Waste Processing: Electronic Waste II

Wednesday AM — Room: Caesar 4
October 15, 2008 — Location: Hilton Cancun Golf & Beach Resort

Session Chair: Christina Meskers, Umicore

10:30 AM Keynote

ReLCD – Recycling and Re-Use of LCD Panels: *Bernd Kopacek*[1]; [1]Austrian Society for Systems Engineering and Automation

Nowadays more and more consumers substitute their conventional TV-sets and computer monitors by LCD panels. In the near future huge amounts of LCDs will start coming back to recycling. In the last 2 years an EU-funded project investigated best available re-use and recycling technologies.

10:55 AM

Recycling System of Waste Materials from Discarded Mobile Phone: Kunihiko Takahashi[1]; *Gjergj Dodbiba*[1]; Toyohisa Fujita[1]; [1]University of Tokyo

Recycling of various materials from the discarded mobile phones is very important in terms of saving the resources and protecting the environment. Generally speaking, various metals from the metallic parts of mobile phones can be recovered by using smelting and purification techniques. The recycled metals can then be used to fabricate other new products. For instance, indium is extensively being used in the production of the liquid crystal displays (LCD). It should be noted that the concentration of indium in liquid crystal displays is 70 times greater or more, when compared with its concentration in zinc ores. Nevertheless, the LCDs from the discarded cellular phones are generally discarded without recovering indium. This paper is an introduction of the recycling system of various materials from the discarded mobile phone, currently available in Japan. In order to illustrate and support and the conclusions of study, a series of experimental results are presented.

11:15 AM

Silica Nanopowder from Waste Silicon Sludge and CFD Modeling of the Flame Spray Pyrolysis Process: Miguel Olivas-Martinez[1]; *Hong Sohn*[1]; Hee Dong Jang[2]; [1]University of Utah; [2]Korea Institute of Geoscience and Mineral Resources

Tetramethylorthosilicate (TMOS), a precursor of silica nanoparticles, is prepared from the waste silicon sludge, followed by the synthesis of silica nanoparticles from the TMOS by flame spray pyrolysis. A two-dimensional multiphase computational fluid dynamics (CFD) model for the flame spray pyrolysis (FSP) process for the synthesis of silica nanoparticles has been developed. The model incorporates the governing turbulent equations of overall continuity, momentum, energy and species mass transport to represent the gas phase and the population balance model (PBM) to account for the silica nanoparticles. The model has been validated with experimental data in terms of gas temperature and average particles size.

11:35 AM

Studies on Bromination and Volatile Separation of Metallic Oxides by Gaseous Products from Thermal Decomposition of TBBPA: *Mariusz Grabda*[1]; Sylwia Oleszek-Kudlak[1]; Michal Rzyman[1]; Etsuro Shibata[1]; Takashi Nakamura[1]; [1]Tohoku University, Institute of Multidisciplinary Research for Advanced Materials (IMRAM)

Thermodynamic considerations indicate that heavy metal oxides should easy react with HBr, main gaseous product of thermal decomposition of tetrabromobisphenol A (TBBPA), forming low boiling points metallic bromides suitable for volatile separation. The metal oxides are also expected to qualitatively and quantitatively affect decomposition of this flame retardant. Mechanisms and kinetics of the bromination reactions must be well recognized prior to developing of a new treatment process for simultaneous recycling of plastics waste containing brominated flame retardants (BFRs) and metal oxides (printed circuit boards, automotive shredder residue, plating sludge, metallurgical dusts). In this work, a differential scanning calorimeter was applied to investigate possibility and conditions of bromination of ZnO, PbO, CuO and Fe_2O_3 by product of thermal decomposition of TBBPA. The bromination reaction with ZnO was studied extensively using a laboratory-scale furnace. The formed solid and gaseous products were analyzed by XRD, EPMA, ICP, IC and GC-MS methods.

11:55 AM

Studies on Bromination Reaction of Heavy Metal Oxides by $SbBr_3$ and TBBPA with Thermal Methods: *Sylwia Oleszek-Kudlak*[1]; Mariusz Grabda[1]; Michal Rzyman[1]; Etsuro Shibata[1]; Takashi Nakamura[1]; [1]Tohoku University

There is well known that tetrabromobisphenol A (TBBPA) and many systems based on synergistic effect of brominated organic compounds with Sb_2O_3 are extensively used as effective brominated flame retardants (BFRs) in many plastics, textiles, etc. Thermal degradation of BFRs-containing plastics leads to formation of hydrocarbons and gaseous compounds such as HBr and $SbBr_3$. Our thermodynamic considerations indicate that these gases can act as bromination agent of metallic oxides moreover, these metallic oxides have a thermodynamic tendency to be brominated easier than Sb_2O_3. The aim of this study was to investigate experimentally the reactivity of selected metallic oxides such as ZnO, PbO, CuO, Fe_2O_3, and Sb_2O_3 with: 1) HBr, originating from thermal decomposition of TBBPA, and 2) $SbBr_3$ which is formed during thermal degradation of brominated flame retardant plastics. The thermal treatments of the mixture of compounds of interest have been investigated by thermogravimetry coupled with mass spectrometry (TG-MS).

General Recycling and Solid Waste Processing: Heavy-Metal Containing Waste II

Wednesday AM
October 15, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Christian Ludwig, PSI /EPFL

10:30 AM Keynote
Removal of Lead, Cadmium and Boron from Um-Gheig Pb-Zn Spent Ore Sample: *Mohamed Mahdy*[1]; Mohamed El Shahat[2]; Omneya El Hussaini[1]; Galal Abd El Wahab[1]; [1]Nuclear Materials Authority; [2]Ain Shams University

Um-Gheig Pb-Zn representative sample was collected from the main adite of Um-Gheig mine along Red Sea coast in Egypt. Its chemical analysis shows that, it contains 16% Zn, 2.3% Pb, 0.1% Cd and 0.1% B as elements of interest. After H2SO4 agitation leaching, the chemical composition of Um-Gheig Pb-Zn deposit ore residue assayed 2.26% Pb, 1.5% Zn, 0.085% B and 0.01% Cd. This residue was leached with 20% HCl at S/L ratio 1/3 for 2 hours at 80°C. The chloride leach liquor was found to contain 18 g/l Pb, 13 g/l Zn, 0.1 g/l Cd and 0.75 g/l B with the corresponding leaching efficiencies 79%, 86%, 100% and 88% respectively. Lead was precipitated from the chloride leach liquor using concentrated H2SO4 to obtain PbSO4 with precipitation efficiency 96%. While boron was extracted by the selective resin Amberlite IRA743 with loading efficiency of 80%. On the other hand, Zn and Cd were precipitated using Na2S solution with 86.7% and 100% recovery efficiencies respectively.

10:55 AM
Experimental Investigation of Metal Recovery and Treatment for Smelting Residue by "Dry-and-Wet" Process: *Atsushi Shibayama*[1]; Atsushi Yamatodani[2]; Yasunori Higuchi[2]; Shigeru Sunagawa[2]; Eiki Ono[1]; [1]Akita University; [2]Godo Shigen Sangyo Company, Ltd.

In metallurgical process for non-ferrous metals, smelting residue (inc. smelter flue gas) is inevitably generated as secondary product. In this research, some experimental feasibilities were investigated to recover/remove Cu, Pb and As from the residue. Primarily, the removal of As from the residue was examined by H2SO4 solution as a double stage leaching, to recover Cu from the leach residue. And then, to recover and separate Cu from impurities from the 2nd leached solution, solvent extraction was examined by using LIX-84I as a solvent. Several experimental conditions were obtained to recover Cu and Pb, to remove As from the residue. For the leaching stages, the removal of 90% As and the leaching rate of 85% Cu could be achieved by 0.25 mol/l and 1.0 mol/l H2SO4 solution, respectively. On the other hand, the extraction of over 90% Cu and stripping was carried out by solvent extraction.

11:15 AM
Films Based on Leather Scrap: Manufacture and Biodegradation: *Adriane Rodríguez*[1]; Claudia Mählmann[1]; Angela Diehl[1]; Valeriano Corbeline[1]; Diosnel Rodríguez[1]; [1]Santa Cruz do Sul University

The present work aims at to develop a methodology of digestion of the leather scrap and extration of the collagen for attainment of films and to evaluate biodegradation processes on the chrome shaving digested, as well as on the films gotten with the use of cultures of Aspergillus sp. The leather scrap was collected of tanneries of the region around the Santa Cruz do Sul University. For the digestion with oxalic acid was used and the purification of the collagen was carried through the precipitation method with ammonium sulphate. The best formularization of film was gotten with the addition of 10% glycerol and 2% formaldehyde. Samples of this film had been submitted to the evaluation of its mechanical properties, resistance to the impact, water absorption and, later submitted to the biodegradation assays.

11:35 AM
Prediction of Trace Elemental Flows during the Reaction of Bottom Ashes with Chloride-Rich Cement Dusts: *Simona Regenspurg*[1]; Virginie Silberstein[2]; Christian Ludwig[2]; [1]École Polytechnique Fédérale de Lausanne/ Paul Scherrer Institute; [2]École Polytechnique Fédérale de Lausanne

Residues from waste incineration (bottom ashes) form large amounts of heavy metal-rich waste. Theoretically, heating and the addition of chloride to the ashes could remove the heavy metals by formation of volatile metal chlorides. This allows to re-use the remaining ashes, for example, as construction materials. In the proposed process we used waste products from the cement industry (bypass dust) as chloride additives to the bottom ashes. We aim to determine experimentally the optimal conditions to remove heavy metals from the ashes and to simulate this process by geochemical modeling. In our experimental set-up we investigate heavy metal flows by heating of differently composed mixtures of bottoms ash and bypass dust in dependence of different furnace temperatures (500-1200 C). Furthermore, we investigate the reactivity of the resulting product with respect to its leaching characteristic in order to predict if it can be landfilled in agreement to Swiss regulations.

11:55 AM
Recovery of Metal Values from Industrial Waste Water in Galvanization Process: Mahmoud Rabah[1]; F. E. Farghaly[1]; *M.A. Motaleb*[1]; [1]Central Metallurgical Research and Development Institute

Wastewater from industrial galvanization industry was reclaimed under current flow stream conditions. Results showed that the raw water contains 0.7% by weight total suspended solids (TSS) causing turbidity amounting to 30. Measurements of Zeta potential as a function of pH revealed that solid separation takes place at pH 9. Addition of H_2O_2 to the polmer solution helps to oxdize ions of iron and zinc metals toinsoluble ferric oxide and zinc hydroxide to a higher state of oxidation. Addition of 5 mg/L of cationic magna flocculants polymeric solution helps the rapid separation of the turbidity. Separation of floccules so formed takes place by filtration. Addition of peroxide ions to the turbid wastewater confirms the physical stability of the flocs so formed. Impurity flocculation takes place in few seconds. Maximum temperature for safe solid removal was <30°C. The treated water was pure and safe for recycling or use in domestic purposes.

12:15 PM
Thermical Recycling Process of Metal Containing Plastics for Metal Recycling Plants: *Michael Potesser*[1]; Burkhardt Holleis[2]; Helmut Antrekowitsch[1]; Stefan Konetschnik[1]; [1]University of Leoben; [2]Messer Austria GmbH

The direct charging of metal containing plastic from external and internal recycling processes into metallurgical furnaces is nearly impossible in case of the processes itself, off gas systems, dioxin formation, filter burnings and gas flow conditions. Due to increasing energy costs and stronger recycling and landfill restrictions, thermical recycling processes with the goal of a "Zero-Waste-Technology" get more and more important. Possible application fields for this process gas which contains a high amount of burnable compounds are as follows: The fuel gas reduction in metal recycling plants with shaft or shortdrum furnaces or the reduction of natural gas with oxygen in the post combustion. Goals of the investigation are the recycling possibilities of plastic from the metal recycling. The typical material flow in the special pyrolysis process (treatment waste, process gas, reaction coke) was determined. This data built the base of the process routes development and an economic calculation.

Remediation of Contaminated Soil and Industrial Sites

Wednesday AM
October 15, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Hiroshi Nakazawa, Iwate University

10:30 AM Keynote
Purification of Oil-Contaminated Soil by Flotation: *Georgios Anastassakis*[1]; Nickolaos Georgiou[1]; [1]National Technical University of Athens (NTUA)

Soil contamination by oil as well as by other organic pollutants poses a major problem to the environment. Various methods have been used to remove organic contaminants from soil, such as: biological, thermal, chemical and physical. Methods based on Mineral Processing principles have also been used (cyclone separation, gravimetric separation, attritioning and washing). This paper studies the possibility to remove a rich-in-contaminant soil fraction by applying flotation. The contaminated soil was artificially prepared by mixing soil with oil. Sodium dodecylsulfate and a tertiary amine were used as collectors. The effect of collector quantity added, conditioning time and pH was studied. The results showed that the removal of a rich-in-contaminant soil is feasible while a clean fraction is also produced. In some cases, the removal of oil-contaminated soil approaches or reaches 100%.

10:55 AM
Biodegradation of Dichloromethane in the Groundwater in Illegal Waste Dumped Area: *Hiroshi Nakazawa*[1]; Wataru Hareyama[1]; [1]Iwate University

About 800,000 tones of wastes have been piled up or buried illegally at prefectural boundary area between Aomori and Iwate prefectures. Over 200 drums that contained organic solvent were buried at a spot and the solvent leaked from the drums resulting into the pollution of soils and groundwater. Dichloromethane (DCM) is one of pollutants and its concentration in a groundwater in this spot was over 100ppm. We studied whether bacteria inhabit in the groundwater in the polluted area degrade DCM. Gas-tight vials with 10 ml of groundwater samples and 5ml of headspace were shaken at 25°C. After 10 days of shaking, DCM concentration in a sample decreased from 120ppm to not-detected level and chloride concentration increased, indicating that DCM was degraded biologically. Those bacteria would be utilized to remedy contaminated groundwater and soils in the polluted area.

11:15 AM
In Situ Bioremediation of an Alkaline Soil Polluted with Heavy Metals: *Stoyan Groudev*[1]; Irena Spasova[1]; Marina Nicolova[1]; Plamen Georgiev[1]; [1]University of Mining and Geology

An experimental plot containing alkaline soil polluted with heavy metals (copper, zinc, cadmium, lead) was treated in situ by stimulating the activity of the indigenous soil microflora, which contained different metal-solubilizing microorganisms. This was achieved by adding solid biodegradable organic substrates (cow manure, plant compost, straw) and zeolite saturated with ammonium phosphate to the soil and periodically irrigating it with water solutions containing lactate, acetate and magnesium chloride. An efficient removal of the above-mentioned heavy metals was achieved via the drainage waters within 18 months of treatment. The metals were solubilized mainly as complexes with the organic acids added by the irrigating water solutions or secreted by the indigenous heterotrophic microorganisms. A portion of the lead was solubilized as complexes with chloride ions. The soil effluents containing dissolved metals were efficiently treated by means of a constructed wetland located near the experimental plot.

11:35 AM
Remediation of Contaminated Soils and Industrial Sites: *Emilia Kostakeva*[1]; Magdelinka Yaneva[2]; [1]EKOEM-K; [2]University of Architecture, Civil Engineering and Geodesy

The environment protection in every passed year became more and more significant problem of the mankind. Up to the last decade the only way to make the domestic waste harmless in Bulgaria was deposition on the uncontrolled landfills without undertaking actions for protection of the soils. This causes also spreading the pollution over the surface and underground waters and that is why actions are undertaken for remediation of contaminated soils. This is achieved by making projects for closing of polluted sites. In the present paper some projects for closing of polluted areas are discussed. The actual conditions are examined and project decisions for prevention the surface waters penetration into the waste are presented. In this way the pollution of the soil is stopped and the soils gradually are remediated.

11:55 AM
Production of Copper and Zinc Oxide in the Process of Brass Scrap Recycling: *Milorad Cirkovic*[1]; Vlastimir Trujic[1]; Mile Bugarin[1]; [1]Mining and Metallurgy Institute Bor

Industrial scale testings were performed in the plant of Bor Company. Charging sample of the brass scrap was from 4 to 5 tons for each particular test. All operations in industrial scale investigations were carried out in one furnace.For the aim of successful performance of experiments, and primarily for safety and prevention of risk of toxic contamination of working environment, a plant was designed and constructed for cooling and wet dedusting of gases formed during smelting process, zinc removal and flame refinement of molten metal. For the requirements of industrial investigations a complete plant for cooling and wet dedusting of gases was constructed for brass scrap processing. In this plant, original ultra-sonic water spraying devices have been installed. The efficiency of such simplified system for gas treatment was 98.6%.

Resources, Monitoring and Characterization of Waste

Wednesday AM
October 15, 2008

Room: Caesar 6
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Kalyani Das Sarkar, Steel Authority of India Limited

10:30 AM Keynote
Hyperspectral Imaging Based Sorting Strategies in Solid Waste Recycling: *Giuseppe Bonifazi*[1]; Silvia Serranti[1]; [1]Sapienza Università di Roma

The application of hyperspectral imaging technique to the characterization of solid waste particles has been investigated. In particular, the study was addressed to explore the possibility offered by "real time imaging based spectroscopy", in the field of solid waste recycling. Different waste materials characteristics can be detected analyzing their surface spectral response when properly energized by a suitable source. The proposed approach can be profitably applied to develop specific sorting actions addressed to recognize and separate different materials and/or to develop control strategies finalized to evaluate the performance of a separation equipment and/or of a processing stage. Selected case studies related to different solid waste recycling sectors, in which the application of hyperspectral imaging can be profitably utilized, are described: glass recycling, fluff from car dismantling and bottom ash from solid waste incinerator.

10:55 AM
Influence of Fine Particulate Material Pollutants on Human Health at University Campus: *Ruth Marlene Santana*[1]; Marcondes Pacheco[1]; Michel Tieccher[1]; Juliano Urach[1]; [1]Santa Cruz do Sul University - UNISC

One of the components of urbana air pollution is the particulate matter (PM) whose main source is the combustion of fossil fuel from motor vehicle emission. The PM presents a potentially risk to human health because of their small size to penetrate in the lungs, causing a increased cardiopulmonary morbidity and mortality. The subject of this work is to monitor the PM emitted in the bus terminal Santa Cruz do Sul University, Brazil and to evaluate the influence over the students health. It was selected the centre of the bus terminal for monitoring and was used a colector of high-volume

(HV-PM10) for sampling of PM <10μm in a week, and on the other hand, it will be collected statistic dates of students number with respiratory problems from university medical post. Preliminary gravimetric results carried out in 24 h showed a high index of PM of 200 μg/m3.

11:15 AM

Management of Bio-Medical Waste in Captive Hospitals of Steel Authority of India Limited, A Public Sector Undertaking: *Kalyani Das Sarkar*[1]; [1]Steel Authority of India Limited

Steel Authority of India Limited, a Public Sector Undertaking with a production capacity of 14 million tones of crude steel, is India's largest steel maker and ranks among the leading steel producers in the world. SAIL owns and operates eight manufacturing plant – five integrated steel plants at Bhilai, Durgapur, Rourkela, Bokaro and Burnpur producing carbon steel, and three speciality steel plants. All integrated steel plants have hospitals of 650 – 750 bed capacity with modern facilities to serve it's employees and adjoining localities in a clean and sustainable environment. According to the Bio-Medical Waste(Management and Handling) Rules, 1998 and as amended to date, all Bio-Medical waste which is generated during the diagnosis, treatment or immunization of human beings or in research activities pertaining thereto or in the production or testing of biologicals are to be categorized and taken to any facility wherein treatment, disposal of this waste or processes incidental to such treatment or disposal is carried out. The hospital management has created adequate treatment facility for Sharp and Infectious Waste, Pathological Waste and Anatomical Waste through Autoclave, Shredding Machine and developing deep burial pits. Some of these hospitals is ISO 9000-14000 certified. Use of above said treatment facilities in these hospitals are discussed in this paper.

11:35 AM

Monitoring Greenhouse Pollutants from Human Source: Carolina Niedersberg[1]; Vinicius Dalenogore[1]; Mauricio Almeida[1]; *Ruth Marlene Santana*[1]; [1]Santa Cruz do Sul University - UNISC

The level of air pollution is growing worldwide and many of them present great potential in the global heating such as CO2 and methane (CH4) gases. The CO2 is the main component of the greenhouse and represents 55% of the anthropogenic emissions. However, the CH4 has a heating potential 21 times higher than CO2. One of the generating sources of CH4 is the farms where there are a great amounts of cattle. In sight of this, the aim of this work is to monitor and evaluate these pollutants generated by the human source. Two locals were selected for this study, the treatment plant of sewage and a bathroon, both at the University of Santa Cruz do Sul-UNISC. Partial results evaluated in one day showed that the amount of CO2 in both locals were higher than 7,2x105 μg/m3. The concentration of methane was from 17 to 92 μg/m3 (level allowed).

11:55 AM

The Integrated Management of Textile Wastes - A Strategic Tendency for Developing a Sustainable Textile Industry in Romania: *Emilia Visileanu*[1]; Eftalea Carpus[1]; [1]Research-Development National Institute for Textile and Leather

The preserving of harmony and of the man-nature equilibrium, at the same time with the economical-social progress, a basic concept of the sustainable development, represents the reconciling solution for the two opposed tendencies: the economic growth and the environment resource protection. Having in view the complexity of the consequences created by wastes, the solving manners can be achieved only within a waste integrated management that should consider all the implied factors, namely: - the potential generators; - the commercial chain that launches products into circulation; - the effective producers of wastes; - the operators that ensure the waste collecting and transporting; - the economic operators that act for waste recycling into the productive circuit; - the economic operators that act for waste reducing by manufacturing flows. The transforming of the waste recovering and recycling into a life and economical-social action way ensures the successful implementing of the sustainable developing strategy.

Trade Policies and Incentive Structures in Recycling

Wednesday AM
October 15, 2008

Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Randolph Kirchain, Massachusetts Institute of Technology

10:30 AM Keynote

Legal and Policy Aspects of Current Mergers and Acquisitions in Recycling and Metal and Materials Processing Industries: *Migen Dibra*[1]; [1]Midgen Law

Recycling has become in recent years an important industrial activity driven by both environmental and business factors. The environmental factor requires the recycling of products and wastes in order to assure a clean environmental while the business factor is related to the fact that the classic raw materials such as minerals are becoming increasingly rare while the need for metals and materials is at an all-time high. As a result recycling activity today is not only carried out by separate recycling companies but also by original metals produces that have embraced add-on recycling activities in parallel to their metal and materials extraction processes. Since the latest tendency is becoming even dominant today the recycling industries are directly affected by the most distinctive movement in the industry: massive mergers and acquisitions among major producers. This movement has changed the old relationship between recycling and classic extraction companies and has effectively changed the global picture and the horizon of the processing industries that used to be known previously. Today's mergers and acquisitions are much more numerous, happen more frequently, involve bigger and larger scales and are globally stretched in transnational and transcontinental levels. Furthermore it seems to be much easier for them today compared to the past where regulators and courts have often prohibited similar large scale mergers and acquisitions citing antitrust and competition laws that are still in force today and whose role is to assure a dynamic and efficient economy and provide competitive prices for quality products and services. This new reality makes more than necessary to conduct and overview of legal and policy aspects of the recent mergers and acquisitions of various companies. This is precisely the subject of this lecture along with an abridged analysis of the current antitrust and competition laws in USA, European Union, Canada and Australia and some related court decisions. It is concluded that some new factors in the today's reality such as market globalization and new technologies can influence a different interpretation of existing antitrust and competition laws and may also justify possible amendments of the legal and policy framework.

10:55 AM

Measuring Sustainability of Solid Waste Management (SWM) in Developing Countries: A Case Study in Malaysia: *Siti Saat*[1]; [1]Strathclyde University

The management of waste materials is a problem worldwide. In the developing countries, waste management is becoming an acute problem as urbanization and economic development increase leading to larger quantities of waste materials requiring management in these countries. The issues of exportation of solid waste from developed to developing countries, green process and product International Environmental Standards and life cycle assessment will be critically reviewed. This study seeks to make explicit this interrelationship and to formulate a policy framework for Sustainable Solid Waste Management in Malaysia. This study examines the application of Material flow analysis (MFA) as a technique to measure sustainable solid waste management in Malaysia. The research also aims to understand the behavior and attitude of household towards MSW, focusing on the scope for change that may improve quality of life and sustainability of solid waste management.

11:15 AM

Modeling the Economic and Environmental Performance of Recycling Systems: *Jeffrey Dahmus*[1]; Susan Fredholm[1]; Elsa Olivetti[1]; Jeremy Gregory[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology

As recycling systems become more widespread, understanding the economic and environmental performance of such systems becomes critical, both to evaluate existing systems and to design and implement new systems. The work presented here focuses on modeling the economic and environmental performance of recycling systems. These models aim to provide both a broad perspective on recycling systems and a reliable basis for system evaluation. The model developed here is divided into three main components - collection, processing, and system management - which are common to most recycling systems. Each of these components is analyzed using a range of techniques, including network models to evaluate collection, and material flow analyses to evaluate processing. The outputs from these analyses are in turn used with both process-based cost models, to evaluate the economic performance of a recycling system, and with life cycle assessment tools, to evaluate the environmental performance of a recycling system.

11:35 AM

A Methodology for Evaluating and Comparing Recycling Systems: A Case Study of Electronics Recycling Systems: *Jeremy Gregory*[1]; Susan Fredholm[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology

Jurisdictions across the world have struggled to create and finance systems that can effectively collect and process electronics waste (e-waste). Many different system architectures have been proposed and implemented, but it is difficult for policy-makers and system architects to compare the costs and benefits of different systems, particularly when the systems operate in different contexts. This paper presents a systematic methodology that seeks to address this challenge and uses data from several existing electronics recycling systems across the world to illustrate its implementation. The methodology characterizes three main system characteristics: architecture (e.g., financing and collection methods), context (e.g., jurisdiction population, density, and wages), and performance, both economic and materials collection. A comparison of systems in Asia, Europe, and North America with different system architectures and contexts illuminates the importance of using the methodology to discern the extent to which architecture and context drive system performance.

11:55 AM

Incentives for Recycling: Mitigating Risks to Downstream Firms: *Elisa Alonso*[1]; Frank Field[1]; Randolph Kirchain[1]; [1]Massachusetts Institute of Technology

There are a number of environmental incentives for increasing recycling, including the reduction of landfilled waste, energy consumption, and resource use. Firms close to materials production know that recycling can also be financially beneficial. The goal of this paper is to explore the conditions under which recycling can provide financial benefits even for downstream firms and even in the absence of significant price discount. Such incentives emerge when secondary material can substitute for primary, providing an alternative source. Specifically, this paper examines dynamics of recycling and the potential for such recycling to reduce firm financial risk in the case of platinum using a dynamic, behavioral simulation model of the primary and secondary markets. Since the secondary supply of platinum depends on a separate supply chain from primary extraction, over time, recycling can cut primary consumption, reduce overall costs to firms, and reduce the impact to firms of price swings.

General Recycling and Solid Waste Processing: Composite Materials IV

Wednesday PM
October 15, 2008

Room: Caesar 1
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Sergio Monteiro, UENF

2:00 PM Keynote

Use of Co-Products from Oil Extraction of Sunflower for Manufacture of Composites: *Adriane Rodríguez*[1]; Claudia Mahlmann[1]; Rosana Schneider[1]; Nelma Balbinot[2]; Diosnel Lopez[1]; [1]Santa Cruz do Sul University; [2]Mestrado em Tecnologia Ambiental-Santa Cruz do Sul University

The use of co-products of the sunflower oil has been studied aiming at the production thermoplastic composites. Thermoplastic composites have been processed in polyethylene matrices of virgin low linear density (PELBD) or post-consumption polyethylene. Samples have been formulated with different mass fraction of scarce phase (cake) and material characterization has been achieved by mechanical testing of traction and Shore D hardness and by physical testing of density. The results have demonstrated better properties to thermoplastic composites with industrial sunflower bran.

2:25 PM

Recycling of Tire Rubber in Porous Asphalts Using the Dry Process: Mechanical Characterization and Performance Evaluation of Mixes: *Marco Pasetto*[1]; Nicola Baldo[1]; [1]University of Padova

Recycling of tire rubber in the road pavement, may be one of the best way to reduce waste tires in large quantities and, at the same time, improve some engineering properties of asphalt mixtures. The paper discusses the results of an experimental study, developed in order to analyse the potentialities of crumb rubber from road tires in bituminous mixtures, using the dry process. Two types of porous asphalt mixtures and reference mixes without rubber were formulated by the traditional Marshall methodology, and mechanically evaluated by means of the Indirect Tensile Stiffness Modulus test, the Creep test (with confinement), and the Indirect Tensile Fatigue Test. Results of this study indicate that the tire rubber has a positive influence on the performance characteristics, depending also on the grading and volumetric properties of the mix being studied: an interesting increase of the fatigue life, a better stiffness behaviour at lower temperatures and a bigger permanent deformation resistance at high temperatures are guaranteed.

2:45 PM

Study of the Buriti Waste Fiber as a Possible Reinforcement of Polyester Composites: *Sergio Monteiro*[1]; Felipe Lopes[1]; Lucas Costa[1]; Ludy Motta[1]; Luiz Fernando Santos[1]; [1]State University of the Northern Rio de Janeiro - UENF

Environmentally correct materials like the lignocellulosic natural fibers, which are renewable and biodegradable, are being extensively investigated as possible substitutes for synthetic fiber in polymeric composites. Several natural fibers have never been thoroughly investigated as possible composite reinforcement. The fiber obtained from the leaves of the burity (Mauritia flexuosa) palm tree is one example. Therefore, the objective of this work was to study the properties of butiti waste fibers, in amounts of up to 40 wt.%, reinforcing polyester composites.

3:05 PM

The Possibility of Metallurgical Waste Exploitation in Dye through of Concrete Composites Matrix: *Vladimir Cablik*[1]; Miroslav Svoboda[2]; Rudolf Tomanec[3]; Martin Vyvazil[2]; Peter Fecko[1]; Maria Kusnierova[4]; [1]Vysoká Škola Bánská - Technical University of Ostrava; [2]Research Institute of Building Materials, JSC; [3]University of Belgrade; [4]Institute of Geotechnics SAS

This work describes the characterization of red mud - a waste generated by the Bayer process in the aluminium industry - which causes environmental problems. Residue of the alumina leaching from bauxite was analyzed for mineral compositions of the mineral ore and its residue for chemical

composition, density, and grain-size composition. The residue was calcinated and finally tested as a pigment for use in the building material industry. The test blocks were tested on physico-mechanical properties, especially on strength characteristics.

3:25 PM Break and Closing Session

General Recycling and Solid Waste Processing: Non-Ferrous Metals V

Wednesday PM
October 15, 2008

Room: Caesar 7
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Lifeng Zhang, Missouri University of Science and Technology

2:00 PM Keynote
The Role of Top Submerged Lance (TSL) Technology in Recycling and Closing the Material Loop: *Markus Reuter*[1]; Robert Matusewicz[1]; [1]Ausmelt Limited

Over many years Ausmelt has explored the many possible innovative applications of Top Submerged Lance (TSL) technology to process (recycle) post consumer materials and industrial intermediate products and residues. A wide variety of such applications have been piloted in Ausmelt's pilot plant in Dandenong and numerous have gone to commercial scale applications globally. This paper will review the varied applications ranging from e-waste recycling, lead and NiCd battery recycling, metals recovery from slags, leach residue processing, electric arc furnace (EAF) flue dust, bottom ash processing, carbon containing residues such as retort ashes and spent pot liner and use of the technology for materials such as automotive shredder residue (ASR) and plastics. These various applications will be examined by referring to the technology and fundamental processing issues involved. Just as importantly, the environmental issues surrounding the processing of such materials will be considered.

2:25 PM
Synthesizing Mn-Zn Ferrite from Spent Zinc Carbon Batteries through Hydrometallurgical Processes: *Taehyun Kim*[1]; Shyn Myung Shin[1]; Jeongsoo Sohn[1]; Jingu Kang[2]; Kangin Rhee[1]; [1]Korea Institute of Geoscience and Mineral Resources (KIGAM); [2]University of Science and Technology (UST)

Studies for synthesis of Mn-Zn ferrite powder were investigated using a series of leaching and co-precipitation processes from spent zinc carbon batteries. 97.9% Zn, 98.0% Mn and 55.2% Fe were leached at the conditions of 100g/L S/L ratio, 2M H2SO4, 60°C, 200 rpm and 6 vol.% H2O2 as a reducing agent. As a result of co-precipitation in the leaching solution, Mn-Zn ferrite was synthesized directly at low temperature in the conditions of pH 12, 80°C, 1.3L/min O2 flow rate and 400rpm. In co-precipitation tests with various variables, the particle size of synthesized Mn-Zn ferrite powder could be controlled and Mn-Zn ferrite powders ranged 0.122-0.240 μm in size and the saturation magnetization with various compositions of Zn(Mn1-xZnxFe2O4 X=0.2-0.8,) ranged 39-91 emu/g and the magnetization of Mn-Zn ferrite increased in the zinc substitution range of $0.2<x<0.5$ but it decreased in the zinc substitution where $x>0.6$.

2:45 PM
The Austrian Model and Key-Factor "X": *Harald Förster*[1]; [1]University of Leoben

From vision to concept, to strategy and to solution, using sustainable technologies and solutions as a basis for future-oriented business in metal finishing, surface engineering and the metalworking SME and industries, .- which has proved successful in Austria. Better and best practice for other industry sectors, - local, regional, national, EU, global -, and for the global economy in a sustainable environment in "One World" should be practiced. The overall, world-wide value-added chain becomes ever more important. The potential for emissions- and waste avoidance, waste recycling and emissions- and waste minimization, material- and energy-optimization, - in some cases up to 100%, s. "zero discharge processes"-, will be considered, including a range of corresponding factors (factors of 2 to 100), e.g factor 5 to 6 for solid waste reduction, factor up to 30 for reducing the burden of discharge to sewer (chemical) and up to factor 100 for effluent volumes. Factors according to the "Club of Rome" -"Meadows with 8" and the "NUP Austria with 10 since 1996, Parlament in Vienna" are being reached and in some cases, exceeded. This approach is intended to form the framework of a globally harmonized legislative approach, -BAT, PIUS, IPPC, ECO-DESIGN -, where costs are accurately and fully assessed, with external costs taken into account.- Indeed, the alternative "end-of-pipe" concepts and "re-actio" approaches are in most cases more expensive in both environmental and economic terms than "preventive" concepts and "pro-actio" methods. The whole concept and solutions of re-balancing and re-equilibrating our world for a world wide eco-social market economy can and should, for example, take its cue from the all-embracing, integrated and co-operative, successful and sustainable Austrian Model.

3:05 PM
The Combined Technology of Cobalt-Manganous Slimes Processing: Anatoly Sudnev[1]; Dmitry Panov[1]; Igor Kudryavtsev[1]; Boris Radionov[1]; *Vladimir Skorohodv*[1]; [1]Ural State Technical University

In cobalt production technology at a stage of solutions purification manganous cake (slime) basically containing hydroxides of the specified metals is formed. The possibility of full cobalt recycling in the basic technology of metal production at slime processing with generation of pure manganous compounds is shown. After slime dissolution in sulfuric acid in the presence of reducers the solutions containing cobalt, manganese, nickel and other nonferrous metals are formed. Optimum conditions of selective precipitation major part of cobalt by sodium hydroxide from the obtained solution are defined, thus more than 95% of manganese are remained in the solution. The cobalt precipitate is directed to the basic technology and the solution is purified by sorption. The most effective sorbents are chosen, optimum modes of its use are found. Examples of manganese recovery from the purified solutions as MnO_2, $MnCO_3$, $Mn(OH)_2$ with a ratio manganese: impurities more than 3000 are presented.

3:25 PM
Transformational Roasting and Acid Leaching of Nickel-Copper-Arsenic Sulphide Precipitates: *Preston Holloway*[1]; Thomas Etsell[1]; [1]University of Alberta

The copper residue which is produced as a byproduct of the electrorefining of nickel matte from CVRD-Inco's Thompson refinery consists of a mixture of copper, nickel and arsenic sulphides and represents a high grade waste of significant tonnage. The effect of roasting this material with Na_2CO_3 and $Ca(OH)_2$ on the deportment of sulphur, arsenic, copper and nickel was studied using a combination of techniques, including Design of Experiments tests, chemical and mineralogical analysis, and diagnostic leaching. A number of different potential process routes for treating this material at the Thompson refinery, based on the results of this study, will also be discussed.

3:45 PM Break and Closing Session

General Recycling and Solid Waste Processing: Non-Ferrous Metals VI

Wednesday PM
October 15, 2008

Room: Caesar 8
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Thomas Battle, Midrex Technologies

2:00 PM Keynote
Stabilization and Storage of Thermal Residues by Accelerated Carbonation: *Lourdes Yurramendi*[1]; Susana Caballero[1]; [1]INASMET-Tecnalia

Air Pollution Control (APC) ashes from Municipal Solid Waste Incineration (MSWI) plants need to be treated prior to landfilling due mainly to their heavy metals content. This research evaluates the capacity of the APC residues to sequester carbon dioxide, while the ash becomes stabilized for storage. It has the benefit of using two wastes, with no addition of any raw material. APC samples from different MSWI plants treated by gas/solid accelerated carbonation at different temperatures and carbon dioxide concentrations to evaluate the residue behaviour to the process. The extent of carbonation was evaluated by means of weight gain upon carbonation and by the measurement of the final carbonate content. The APC residues were analyzed before and after the treatment in order to know their composition and their leaching behaviour according to the criteria for the acceptance of wastes at landfills established by the European Council Decision 2003/33/EC.

2:25 PM
Processing of Zinnwaldite Wastes to Obtain Lithium and Rubidium Compounds: *Jitka Jandova*[1]; Hong Vu[1]; [1]Prague Institute of Chemical Technology

Gypsum and limestone methods were examined in this study to process wastes originating from dressing of Sn-W ores mined in the Czech Republic. These wastes containing 0.20-0.30% Li and 0.10-0.20% Rb were subjected to magnetic separation to obtain a zinnwaldite concentrate with 1.35% Li and 0.95% Rb. It was found that processing of the zinnwaldite concentrate by gypsum method at 950°C it makes possible to extract almost 95% Li into aqueous liquors, whilst rubidium extraction is only 18%. At the same time, it is possible to extract 90% Li and 94% Rb from the identical zinnwaldite concentrate if the concentrate was processed by limestone method at 825°C. The final products of both methods – Li2CO3 and Rb2CO3, were recovered from refining sulphate solutions using K2CO3 as a precipitation agent (gypsum method) and/or from refining hydroxide solutions using gaseous CO2 (imestone method).

2:45 PM
The Immobilisation of As_2O_3-Rich Wastes from Ore Smelting Using Low Temperature Ceramics: *Dan Brew*[1]; Eric Vance[1]; [1]Australian Nuclear Science and Technology Organisation

Arsenic has been immobilised using different precursor materials and synthesis routes. Monoliths have been prepared, in some cases loaded with up to 40% arsenic by mass, and subjected to standard leaching protocols. Where appropriate, samples have been heated to temperatures of up to 1000ºC to enhance their chemical resistance. In each case, the resultant solids are characterised and discussed. Leachant data demonstrate the relative stabilities of the monoliths. Route one is a lime-based wasteform consisting of a Blast Furnace Slag and Ordinary Portland cement blend. Arsenic is associated with iron from the slag and good compressive strengths are obtained. Route two is a geopolymer material consisting of dehydroxylated clay material. In this wasteform, arsenic is incorporated within the framework structure minimising its leaching potential. The third route employs converting As(III) to As(V). The resultant As(V) compounds are encapsulated within the wasteforms described above and characterised accordingly.

3:05 PM
Secondary Phosphorus for the European Fertilizer Industry – Quality of Recovered Products and their Markets: *Ludwig Hermann*[1]; [1]ASH DEC Umwelt AG

Phosphorus is required by every cell of living organisms and essential for plant growth. It is a non-renewable resource that must be mined from natural deposits, going gradually into depletion. Abundant secondary resources are available in sewage sludge and meat and bone meal, with the highest exploitable P concentrations in ashes that remain from widely used combustion and energy recovery from these waste streams. ASH DEC has successfully removed heavy metals and transformed sewage sludge ash into a marketable P fertilizer by application of a thermochemical treatment process. Pilot scale investigations in which ash was treated proved that generally heavy metal limits required by fertilizer legislation can be reached. To achieve a high P availability to crops – an essential fertilizer quality feature – was a more challenging R&D task. Our presentation demonstrates the scientific approach and R&D results that lead from assessment of market requirements to licensed products.

3:25 PM
Efficient Use of Aluminum Scrap in Batching Secondary Alloys and Potential for Sensor-Based Sorters to Improve the Recycling System Efficiency: *Adam Gesing*[1]; Harbeck Harbeck[2]; Bjørn Hansen[3]; [1]Gesing Consultants Inc; [2]CommoDaS GmbH; [3]Tomra Systems ASA

Aluminum metal production, semi-product fabrication, component manufacture and material recycling systems are surveyed for the quantities of various types of production, fabrication, manufacturing and end-of-life scrap. We will then focus on two types of scrap: source-segregated pure scrap that can be used as a diluent, replacing prime Al; and mixed-alloy scrap that could benefit from upgrading by sensor-based particle sorting. The markets and alloys that can utilize the various grades of scrap will be explored, and the need for the various types of upgrading by particle sorting demonstrated. A system-efficient use of scrap does not require closed-loop recycling of products or alloys, but only minimization of losses to oxidation or landfill. Sensor-based sorters can minimize these system losses. We will show examples of where upgrading of Al scrap by sensor-based sorting provides opportunities for profit in the current system, which includes metal production, fabrication, manufacturing and material recycling.

3:45 PM Break and Closing Session

Materials and Energy Efficiency in Process Engineering

Wednesday PM
October 15, 2008

Room: Caesar 2
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Petr Stehlik, Brno University of Technology

2:00 PM Keynote
Engineering Fundamentals of Energy Efficiency: *Jon Cullen*[1]; Julian Allwood[1]; [1]University of Cambridge

Energy is consumed in order to deliver energy services (transport, thermal comfort and illumination); it is these services we desire not energy itself. Therefore significant technical opportunity exists for decreasing energy use while still delivering the same level of energy services. In this paper we present a fundamental analysis of the limits to global energy efficiency, contrasting current energy demand with theoretical minimum requirements in order to identify priorities for technical action. The energy flow-path is traced from primary energy sources, through conversion devices (engines, furnaces, and light bulbs), energy systems (vehicles, building and factories) and finally to the energy services society demands. The results show that 90% of the available energy input from primary sources is currently lost on the pathway to delivering energy services. The mechanisms of energy loss are explored from an engineering perspective and long-term scenarios developed based on the ranking of energy efficiency opportunities.

2:25 PM

Cumulative Energy and Exergy Analysis of Shaft Furnace and Outocumpu Processes of Copper Production: *Kolenda Zygmunt*[1]; Boryczko Bozena[1]; Holda Adam[1]; Donizak Janusz[1]; Escobedo Bocardo Jose[1]; [1]University of Science and Technology

The values of the thermoecological cost of shaft furnace and flash smelting technologies of copper production have been calculated on the basis of adjusted material and energy balances. Exergy analysis has allowed to calculate internal exergy losses using Gouy-Stodola equation together with exergy efficiency. The results show which processes are mostly responsible for the global thermoecological cost and point out processes needed to be improved from thermodynamic point of view. Szargut method of thermoecological cost calculation has been used. Numerical data for analysis have been taken directly from copper industry.

2:45 PM

Energy Savings and Carbon Dioxide Emission Reduction by Use of Advanced Refractory Technology: Bob Drew[1]; Marcus Kirschen[1]; *Alfred Spanring*[1]; [1]RHI AG

Increasing mass and energy efficiency and decreasing carbon dioxide emission values are decisive for sustainable production processes in aluminum, cooper and steel industry. RHI supports these targets by providing a large variety of solutions to high quality refractory linings, optimum lining maintenance and process improvement. In this paper, examples are given for process improvement and increased energy efficiency in copper refining processes, application of purging systems, potential energy savings at electric arc furnaces and ladles in steel industry, and increased energy efficiency by improved heat transfer in anode baking furnace in aluminum industry. In all cases, the use of RHI expertise in close co-operation with the costumer resulted in an improved performance of the reactor lining and the actual high temperature process with positive impact on mass and energy efficiency and, correspondingly, decrease of specific emission values.

3:05 PM

Process and Practice of Reducing the Cr Loss during EAF with De-P Hot Metal Charging Melting Stainless Steel: *Fangyi Zhu*[1]; [1]Baosteel

Based on the thermodynamics of EAF melting stainless steel,the article points out that the main reason of Cr loss during EAF melting stainless steel is oxidization. Analyzed the character of Cr oxidization and reduction, It is pointed out that the effective way to reduce the Cr loss is to control the Si content in EAF charging, to use oxygen in reason and to effectively reduce Cr oxide in slag. The Suitable Si content in material charging can reduce the Cr oxidization. The optimization of oxygen-blowing technology also can reduce the Cr oxidization. Effective reduction can realize the lowest Cr oxide in slag. Applied the integrated control method, the Cr loss during EAF melting stainless steel decreased 43.10%.

3:25 PM

Wastes as Potential Alternative Fuels in Cement Production: *Christos Ftikos*[1]; John Karagiannis[2]; Panagiotis Nikolopoulos[3]; [1]National Technical University of Athens; [2]Hellenic Cement Research Center; [3]University of Patras

Some of the wastes may be potential candidates to be used as alternative fuels in cement production that boasts a lot of environmental benefits. These wastes include a variety of materials like used tires, animal meal, refused derived fuels (RDF), used oils, biomass etc. During the clinker production process, the organic part of the wastes is totally destroyed whereas the inorganic compounds and heavy metals are incorporated in the interstitial phase or substitute calcium or silicon in the silicate phases of the clinker. However, due to their origin these wastes introduce into the cement making process several trace elements that may affect the process itself as well as the properties of clinker. The aim of the present work is to investigate the effects on the properties of Portland cement clinker for two waste materials used as alternative to replace fossil fuels like coal for the production of Portland cement clinker.

3:45 PM Break and Closing Session

Urban Development

Wednesday PM
October 15, 2008

Room: Caesar 3
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Yinlun Huang, Wayne State University

2:00 PM Keynote

Modeling Approach for the Sustainable Development of Industrial Zones under Uncertain Information: Cristina Piluso[1]; *Yinlun Huang*[1]; [1]Wayne State University

Industrial sustainability looks to improve material and energy efficiencies, product quality and variety, and productivity within an industrial zone, thus pursuing the long-term sustainable development of the region. This paper will introduce a systems-based modeling methodology, which can be implemented at the individual plant, supply-chain, or zone level, to model, assess, and evaluate the sustainable development of an industrial network. The models and systems-based approach are useful in the component-based evaluation of regional waste generation and production efficiencies. Implementation of the methodology will provide industrial leaders with the ability to assess the state of industrial sustainability within the zone and evaluate future production options to determine the path with the highest positive impact on both their own sustainability and the sustainability of the overall industrial zone. To demonstrate the efficacy of the methodology, a comprehensive study on sustainable development of an auto-manufacturing focused industrial zone under uncertainty is illustrated.

2:25 PM

Monitoring of Air Quality in the Bus Terminal of an University Campus: Rangel Ghisleni[1]; Lidiane Ratke[1]; *Ruth Marlene Santana*[1]; [1]Santa Cruz do Sul University - UNISC

The major source of environmental pollution in urban areas is the transport sector and its impact on human health and the greenhoouse is preoccupying. In many works of literature is monitored the pollutants in urban cities, however in specific areas such as universities, they are scarce. Therefore, the aim of this work is to monitorate the gaseous pollutans in a bus terminal at Santa Cruz do Sul University-UNISC and to develop a control framework of the air quality. Six points were selected for monitoring, being one of them inside a bus. The monitoring of CO, HC and CO2 were carried out on arrival and departure of the bus. Preliminary results conducted in a day of spring showed that the most critical condition was during the night shift, where the concentration of CO (200 ppm) was the highest, caused by the vehicles increase, due to the larger number of students.

2:45 PM

New Remediation Experience and Technics in the Industrial Site Ex Sacelit inside the Remediation Site of National: *Federica Paglietti*[1]; Vincenzo Di Molfetta[1]; Sergio Malinconico[1]; [1]Instituto Superiore per la Prevenzione e las Sicurezza del Lavoro

The Department of Production Plants and Anthropic Settlements (DIPIA) of ISPESL, realizes technical-scientific reports with the purpose to validate interventions and remediation projects, with particular respect to the health and the safety of the workers. This paper will present the results of the monitoring campaigns realized in the National Interest Site of Milazzo. The monitoring have had as objective, in primis the individuation of the real pollution's state of the area. This allowed to establish proper interventions among which, particularly, the reclamation of packed goods contaminated by asbestos. This activities represents an unique case in the Italian national panorama.

3:05 PM

Lifestyle Changes and Residential Solid Waste Management Planning in Beijing: *Jingru Liu*[1]; [1]Chinese Academy of Sciences, Research Center for Eco-Environmental Sciences

The following lifestyle changes are the basic considerations to forecast the quantity and components of residential waste. Firstly, with the urbanization level increase, 90 percent of people in 2020 will live in downtown areas, within the collection and disposal systems of municipal. Suggested that the waste generating rate will keep at 2 percent per year, and then two times more waste will be generated and collected in 2020 than now. Secondly, with the increase of life standards and improvement of living conditions, the percentage of organic will significantly increase in the future. The sufficient energy content of residential solid waste is a precondition for incineration. It is forecasted that in 2020, incineration will take part of 30 percent of total solid waste disposal in Beijing. Thirdly, the traditional selling waste behavior of households makes the greatest amount of material recovery. When the income increases, voluntary source separation tends to decline.

3:25 PM Break and Closing Session

Waste Conversion and Reutilization V

Wednesday PM
October 15, 2008

Room: Caesar 6
Location: Hilton Cancun Golf & Beach Resort

Session Chair: Bernd Kopacek, Austrian Society for Systems Engineering and Automation

2:00 PM Keynote

Biogas Production from Cassava Waste: *Sunday Ojolo*[1]; Abiola Kehinde[1]; [1]University of Lagos

Anaerobic digestion is being taken seriously because of increasing concerns about the environmental hazards of wastes. The production of biogas, as an alternative source of energy was investigated in a designed and fabricated 200litre biogas reactor. The digester was operated on a batch-fed basis, and the feed stock was cassava waste which is readily available in Nigerian farms. The main aim was to explore other renewable sources as a means of less dependence on fossil fuels. A total of 1.94dm3/60kg waste of biogas was produced in 40 days of hydraulic retention time (HRT) with the average yield of 0.048dm3/day. The gas burned with a bluish colour indicating presence of methane (CH4). Temperature during the period of experiment varied between 27 and 330C. The pH of the slurry after the experiments averaged 3.21.

2:25 PM

Processing of Rice Hull Ash for Production of Soda-Glass: *Ashraf Amer*[1]; [1]Environmental Science Department Faculty of Science

Processing of hull ash of rice is attained through alkaline leaching under pressure to produce soda glass which has its industrial applications in detergents and adhesives. The effect of different factors such as temperature, sodium hydroxide concentration, solid-liquid ratio and leaching time as well as the kinetics of leaching were studied. The work presented here indicates that a promising process might be devised for hydrometallurgical processing of hull ash of the Egyptian rice to produce soda glass. The dissolution of silica is a function of temperature, sodium hydroxide concentration, grain size, and leaching time. Decomposition of >95% of silica is reached under temperature of 180°C at soda concentration of 0.6 M and grain size of <17 μm.

2:50 PM

The Role of Fly-Ash and Rice-Hull-Ash in Preventing the Degradation of Hybrid Al/SiC_p Composites Prepared from Recycled Aluminum: *Martin Pech-Canul*[1]; R. Escalera-Lozano[1]; A. L. Leal-Cruz; M. A. Pech-Canul[2]; J. López-Cuevas[1]; M. Herrera-Trejo[1]; [1]Cinvestav Saltillo; [2]Cinvestav Mérida

The use fly-ash (FA) and rice-hull-ash (RHA) offers the potential for the manufacture of hybrid Al/SiC_p/spinel composites via reactive infiltration, both with recycled aluminum. The main reason behind this statement is the beneficial role that both waste materials play in preventing the degradation of SiC_p reinforcements when the composites are processed with aluminum in molten state. Experimentally, $MgAl_2O_4$ is formed in situ during the infiltration of SiC_p-preforms in the temperature range 1050-1150°C for 50-70 min in argon atmosphere at a pressure slightly above to that of the atmospheric pressure. Results reveal that both FA and RHA help in preventing SiC_p dissolution and the subsequent formation of the unwanted Al_4C_3; and although FA-composites still might be susceptible to corrosion via Al_4C_3 - by the interaction of native carbon in FA with liquid aluminum - a proper FA treatment significantly mitigates its deleterious effect. Primary corrosion mechanisms and strategies to overcome the potential degradation effects are outlined.

3:15 PM

Production of Pure Hydrogen from a Source of Waste and Steam: *Soobhankar Pati*[1]; Kyung Joong Yoon[1]; Srikanth Gopalan[1]; Uday Pal[1]; [1]Boston University

Solid oxide membrane (SOM) electrolyzer has been developed for producing pure hydrogen from a source of waste and steam. The SOM electrolyzer consists of a one-end-closed solid oxygen ion conducting stabilized zirconia (Yttria Stabilized Zirconia) tube containing liquid metal (Tin, Silver, and Copper). The outside of the YSZ tube is coated with Ni-YSZ cermet. The cermet serves as the cathode and the liquid metal in the tube as the anode. The SOM electrolyzer is operated at 800-1150°C by providing a steam-rich feed to the Ni-YSZ cermet cathode and waste feed into the liquid metal anode. The steam is reduced over the Ni-YSZ cermet cathode and oxygen ions are transported through the YSZ tube to the molten metal electrode interface. The oxygen ions undergo anodic reaction and oxidize the waste feed in the liquid metal. An external power source is employed to accelerate the process.

3:35 PM Break and Closing Session

Poster Session

Monday AM
October 13, 2008

Room: Foyer
Location: Hilton Cancun Golf & Beach Resort

The Influence of Cooling Rate and Austenitization Temperature on the Microstructure and Properties of a Medium Carbon Microalloy Forging Steel: *Morteza Abed*[1]; [1]Kavir

A practice was carried out to evaluate the influence of austenitization temperature and cooling rate on the microstructure and mechanical properties of medium carbon microalloyed steel. After austenitization at two temperature of 1100°C and 1300°C the microalloyed steel specimens were cooled to various schedules in order to study the influence of cooling rate and austenitization temperature on the characteristic of microstructure and some mechanical properties. The yield and tensile strength and hardness values were determined. The volume fraction of ferrite and pearlite as the function of cooling rate and austenitization temperature was followed by optical microscopy using MIP technique. The results signify that by increasing the cooling rate both strength and hardness increase. Also the volume fraction of ferrite is increased by increasing the cooling rate. Increasing the austenitization temperature seems to raise the both strength and hardness and also volume fraction of ferrite.

Uses of Aggregates Produced from Marble and Granite Quarry Waste in Asphalt Pavements: A Form of Clean Technology: *Roberto Ribeiro*[1]; Julio Correia[1]; Adriano Caranassios[1]; [1]Centro de Tecnologia Mineral

More than 95% of asphalt pavement materials consist of aggregates. The highway and construction industries consume a huge amount of aggregates annually causing considerable energy and environmental losses. The aggregates are usually produced from neighborhood aggregate quarries or form natural aggregate sources. The use of marble and granite wastes from quarries as aggregates might help meet the increasing demands and slow down any detrimental effects on the environment. Chemical and physical results showed that the use of marble and granite wastes from quarries in the asphalt production is quite fusible. Consequently, granite sawmills would perform a clean technology. This technology would also have an economical impact by not spending on basalt extraction.

A New Synthetic Method of Cyclopentanone with Cyclopentene: *Chao Sui*[1]; Xinyong Li[1]; Zhenping Qu[1]; [1]Dalian University of Technology

Cyclopentanone, one of the most important chemical intermediates, was synthesized by catalytic pyrolysis of adipic acid usually, causing great waste of energy and significant pollution. From the point view of atom economy reaction, it is beneficial to synthesize cyclopentanone by cyclopentene and oxygen. In this paper, some improvements on the Wacker-type catalysts were made: PdCl2 and CuCl2 were substituted by Pd(CH3COO)2 and NPMoV, the latter was a complex polyoxometalate with an average atomic ratio of N/P/Mo/V = 4.2/1.0/3.6/6.8 and partly substituted by ammonium cation, which was favorable to transfer oxygen to Pd(0). The oxidation process was carried out under atmospheric oxygen pressure in aqueous acetonitrile acidified by CH3SO3H, the selective oxidation of cyclopentene to cyclopentanone was successfully achieved and it was found that, under the optimum reaction conditions, at 50°C for 6 hours, the conversation of cyclopentene and the yield of cyclopentanone were nearly 100% and 94.6%, respectively.

Nickel Recovery from the Alloy Al2Ni and the Mixtures Al-Ni, Al2O3-Ni and Al2O3-NiO Comparative Study by Direct Chlorination of the Species: Fabiola Alvarez[1]; Daniel Pasquevich[2]; Ana Bohé[3]; *Georgina De Micco*[1]; [1]Comisión Nacional de Energía Atómica; [2]Comisión Nacional de Energía Atómica-Consejo Nacional de Investigaciones Científicas; [3]Comisión Nacional de Energía Atómica-Consejo Nacional de Investigaciones Científicas-Universidad Nacional del Comahue

The separation of nickel from the aluminum present in spent catalysts and different metallic industrial residues, is proposed in the following systems: alloy Al2Ni and the mixtures 50 wt% Ni + 50 wt% Al, 10 wt% Ni + 90 wt% Al2O3 and 12 wt% NiO + 88 wt% Al2O3. The experiments were carried out in a tubular reactor with a flow of 2 l/h of gaseous chlorine and from 200° to 800°C. The final products of the reaction, extracted from the hottest zones of the reactor where characterized by DRX, SEM, EDS and FRX, as NiCl2 y NiCl2.6H2O while in the coldest regions AlCl3 was deposited in the first two cases and in the other there was a residue of θ, α- Al2O3, sometimes mixed with some remainder of Ni and NiO. The procedure attained different separation factors which showed the optimun conditions for the recovery of both metals.

The Production of Anorthite Ceramics from Marble Powder and Gypsum Mould Waste: *Semra Kurama*[1]; Emel Ozel[1]; [1]Anadolu University

Anorthite is used to produce wall tile, floor tile, porcelain, and especially isolators such as condenser and electrical equipment due to its electrical and heat conductivity properties. This study investigates the possibility of utilizing the marble powder and gypsium waste for anorthite production by substitute for calcite (CaCO3) as a raw material in the preparation of anorthite. The mixture of raw materials was prepared in stochiometric ratio of anorthite. Three different groups of samples were prepared in order to achieve the synthesis of anorthite. In the first group, standard anorthite composition was prepared by using CaCO3, Al2O3 and SiO2 while in the second and third group, marble powder and gypsium waste were added in powder composition instead of CaCO3, respectively. Samples were sintered at varies temperatures (1000-1300 C). The different thermal behaviors were observed in the samples depending on the CaO sources.

Development of Green Rust/Ferrite Process for Treating Selenium Contaminated Groundwater: *Hiroshi Hayashi*[1]; [1]Mitsubishi Materials Corporaton

Remediation of soil and groundwater contaminations by selenium and other heavy metal compounds necessitates the development of water treatment process for selenium compound, especially oxy-anionic selenate species. Although the conventional coprecipitation with ferric hydroxide is suitable for the removal selenite, they are less effective in removing selenate. An alternative method has been desired. Here we develop an alternative process using concentrated slurry containing Fe(II)-Fe(III) hydroxides of green rust. A sludge recirculation technique (High Density Sludge process) is adopted to ensure high solid content for effective selenate removal. Since GRs is slowly oxidized to transform into magnetite, the resultant slurry contains both GRs and magnetite. This process, called the recycled green rust/ferrite process, enables us to treat redox-active contaminants and heavy metal ions. A practical plant 12.5m3/hr has been successfully introduced to treat groundwater contaminated with selenate (1mg/L) and cadmium (2mg/L).

Recovery of Precious Metals from Electronic Scraps: *Isabella Lancellotti*[1]; Fernanda Andreola[1]; Luisa Barbieri[1]; Roberto Giovanardi[1]; Ercole Soragni[1]; [1]University of Modena and Reggio Emilia

Recovery of precious metals (PMs) is a present topic, as they are used almost in every electronic-electric device. Gold is the second PM in order of consumption (following silver) and it is almost ubiquitary in electronics where it mainly finds application to produce bonding wires in integrated circuits and as a coating for contacts and connectors. Given this, discontinued electronic and, with a minor role, electric devices may represent a primary source of PMs as gold mines or jewelery wastes. For instance the concentration of gold in gold ores is commonly between 2 and 15 grams of metal per ton of mineral (average 10ppm), while in electronic circuit boards its concentration is over 10 times higher.The aim of this work is the characterization of different electronics scraps to evaluate the gold concentration, and the selective recovery of this metal using enviromentally-friendly techniques.

Effect of Attrition Scrubbing on the Recovery of Platinum Group Metals from Automotive Catalytic Converters: *Wantae Kim*[1]; Tatsuya Oki[2]; Sangbae Kim[1]; Jaechun Lee[1]; [1]Korea Institute of Geoscience and Mineral Resources; [2]National Institute of Advanced Industrial Science and Technology

Attrition is discussed as one of important processes for the recovery of platinum group metals installed in automotive catalytic converters. This

unique pre-process employs intensive impact and shearing action between converter particles themselves either walls or impellers in liquid phase of mixing vessel to concentrate alumina washcoats on cordierite monoliths by scrubbing and comminution. Alumina washcoats also contain significant amount of cerium oxide and zirconium oxide apart from platinum group metals and they were readily concentrated into fine fractions during attrition. A number of parameters including solid-liquid ratio, retention time and scrubbing media were experimentally tested for their effects on alumina washcoats recovery efficiencies. Maximum recovery efficiencies were achieved where zirconia beads of 0.5-1.0mm diameter were used as scrubbing media in higher solid-liquid ratio.

Effect of Alloying Elements on the Microstructure of the Secondary Ingots Made by Al Used Beverage Cans: *Chayong Lim*[1]; B.S. Han[1]; [1]Korea Institute of Materials Science

The effect of alloying elements on the microstructure and texture of the secondary ingots made by Al UBC was investigated. In aluminum can to can recycling, the second phase particles appeared in the solidification stage must be controlled by heat treatment. The optimum heat treatment condition was 888 K for 5 hrs. The texture in hot rolled sheet was depressed with increasing Mn content, on the other hand, Si and Fe elements promoted the texture development. The textures of can-body sheet should be controlled in the hot rolling and annealing stage because can was formed from cold rolled sheet without heat treatment.

A Comparative Study of Curaua Waste Fibers Reinforced Epoxy Matrix Composites as Building Material: *Sergio Monteiro*[1]; Ailton Ferreira[1]; Felipe Lopes[1]; [1]State University of the Northern Rio de Janeiro - UENF

Environmental issues such as global warming and water pollution are motivating fast changes in scientific and technological paradigms. Special importance is now being given to the so called environmentally friendly materials, which are renewable, recyclable and biodegradable. An example is the natural fibers with increasing industrial applications beyond the conventional uses as baskets, fabrics, ropes and carpets. In addition to traditional natural fibers, others like curaua (Ananas erectifolius) are being investigated for possible use as reinforcement of industrial composites. Since epoxy matrix is not yet incorporated with curaua fibers, the objective of this paper was to study the basic properties of epoxy composites reinforced with different amounts of curaua waste fibers. A comparative analysis aiming at the use of these composites as substitute for conventional building materials was carried out.

Biostimulators from the Waste of Tanning Industry: Karel Kolomaznik[1]; Vera Kasparkova[1]; Klara Kodrikova[1]; *Michaela Uhlirova*[1]; [1]Tomas Bata University in Zlin

Potentially hazardous wastes from leather industry (blue shavings) are processed into various biostimulators within two steps. The first step takes place at high pH (11-12) and hydrolyzation is implemented with potassium alkali, in the second step the pH is lowered to 9 with phosphoric acid after enzymatic dechromation occurs. The resulting hydrolyzates were analyzed in the sense of molecular weight distribution and tested as biostimulators on rape (Brassica napus). The hydrolyzates can be also directly used as universal NPK fertilizers. It has been proved that the nitrate content in the edible parts of tested vegetables (radish, lettuce, and cucumber) was approximately 200 times lower compared to the vegetables fertilized with an inorganic nitrogen fertilizer. The harvests of vegetables fertilized with the hydrolysate and the inorganic nitrogen fertilizer were almost the same.

A Critical Analysis of the Biodiesel Program in Brazil: *Sergio Monteiro*[1]; Luciano Oliveira[2]; Luiz Guilherme Marques[2]; [1]State University of the Northern Rio de Janeiro - UENF; [2]COPPE/UFRJ

Biofuels are gaining a relevant role in today's world not only as a solution for the decreasing petroleum reserves but mainly as a positive contribution to te efforts in global warming mitigation. In Brazil, since 1975, the replacement of gasoline by ethanol started a so-called PROALCHOOOL program, which is now being complemented with the replacement of petroleum diesel by biodiesel. This biodiesel program was officially created in 2005 with mandatory goals, supported by legislation, of 2% addition in 2008 and 5% addition in 2013 into all commercialized regular diesel. In this work, a critical analysis of the Brazilian biodiesel program is presented. The technical aspects related to the different raw materials, including wastes, available for biodiesel conversion as well as the economical conditions associated with production costs and market logistic are discussed. The environmental benefits associated with the retention of greenhouse gases is also discussed.

Infrastructure for Biodiesel Production from Waste Materials in Campos dos Goytacazes, Brazil: *Sergio Monteiro*[1]; Luciano Oliveira[2]; Luiz Guilherme Marques[2]; Valdo Marques[3]; Alexandre Stumbo[1]; [1]State University of the Northern Rio de Janeiro - Universidade Estadual do Norte Fluminense; [2]COPPE/Universidade Federal do Rio de Janeiro; [3]Universidade Estadual do Norte Fluminense/Laboratório de Engenharia e Exploração de Petróleo

Similar to the ethanol program, initiated more than 30 years ago, the recently created biodiesel program in Brazil is expected to rely on private initiative based on agribusiness for vegetable oil production. Campos dos Goytacazes is a large county in the northern of the state of Rio de Janeiro with land still available for oily vegetables plantation in addition to the land traditionally occupied by sugar cane platantion, which is used to produce ethanol. In order to extend the biodiesel program to Campos dos Goytacazes, the State University of Northern Rio de Janeiro (UENF) is conducting a technical project for the development of the basic infrastructure for biodiesel production. In this work, the infrastructure based on versatile equipment for biodiesel esterification built in the Center for Alternative Energy of the UENF is presented.

Biodiesel Produced from Urban Wastes – The Experience of Rio de Janeiro, Brazil: *Sergio Monteiro*[1]; Luciano Oliveira[2]; Luiz Guilherme Marques[2]; [1]State University of the Northern Rio de Janeiro - Universidade Estadual do Norte Fluminense; [2]COPPE/Universidade Federal do Rio de Janeiro

The biodiesel production is normally associated with large plantations of oily vegetables such as soybean and colza, in large rural areas. However, in the municipal limits of the city of Rio de Janeiro, southeast of Brazil, biodiesel is being produced from wastes commonly generated by typical urban activities such as sewage sludge, discarded fat from meat markets and post-used frying oils. In the present work, the experience of producing biodiesel from urban wastes in Rio de Janeiro is assessed. The type of precursor materials, equipments and logistics are presented. The environmental and economical advantages as well as the drawbacks are discussed.

A Park for Renewable Energy at the State University of the Northern Rio de Janeiro: *Sergio Monteiro*[1]; Valdo Marques[2]; Maria Alves[1]; Francisca Pinheiro[2]; Jonas Alexandre[1]; Paulo Roberto Silva[1]; Alexandre Stumbo[1]; [1]State University of the Northern Rio de Janeiro - Universidade Estadual do Norte Fluminense; [2]Laboratório de Engenharia e Exploração de Petróleo/ Universidade Estadual do Norte Fluminense

Brazil is among the few countries with potential for developing all sources of renewable forms of energy. In particular, the country is leading the world efforts of substituting petroleum based fuels for biofuels, such as ethanol and biodiesel. Most of the Brazilian petroleum, which has now achieved self sufficiency, is extracted from offshore wells located at the north region of the state of Rio de Janeiro. In view of the future depletion of petroleum, the State University of the Northern Rio de Janeiro (UENF) has created a Center for Alternative Energies (NEAL) to carry out R&D programs on renewable forms of energy. Today, the main project of the NEAL/UENF is a model park for generation of renewable forms of energy. The objective of this work is to present the structural concept of the park and discuss its contribution in terms of scientific, technological, economical and environmental benefits.

Development of Pharmaceutical Products from the Wastes of Processed Marine Shellfish Resources of India: *Santhanam Ramesh*[1]; [1]SRI Padmavathi School of Pharmacy

The shell (exoskeleton) waste of shell fish such as shrimps and crabs is the raw material in the extraction of chitosan, a polymer. Chitosan has several medical appilications such as reduction in cholesterol; decrease in urea and creatine etc. It is estimated that 40000 tonnes of chitosan may be obtained and foreign exchange to the tune of 600 million US$ could be

earned annually from shellfish wastes. Awareness has to be created among sea food processors to put up plants to convert shellfish wastes into chitosan. Similarly pharmaceutical industries may use chitosan help in the development of new drugs. Types of training and awareness programmes to be organized for entrepreneurs, seafood processors and pharmacists are discussed in this paper.

Formulation and Preparation of Pet Foods from Low Value Fishes of India: *Ramasamy Santhanam*[1]; [1]Fisheries College and Research Institute

India's present annual marine fish catch is 2.9 million tonnes and its low value fishes such as sardines and leiognathids amount to 60%. The fish meal obtained from these resources is mainly used presently an ingredient in live stock and aquaculture feeds. These fishes offer vast scope in the production of pet foods. Pet foods prepared with leiognathid fish meal (60%), maize flour (10%), wheat flour (5%), vitamin and mineral mixture (5%) and water (20%) and experimented with 50 cats and 50 dogs were found to be ideal. Depending on protein level, feeds are being formulated for experimenting with more number of pet animals. Training programs are also planned for unemployed people to popularize pet foods for commercial purposes.

Regulators of the Effective Substances Release from Tannery Waste: *Jan Matyasovsky*[1]; Peter Jurkovic[1]; Jan Kopny[1]; Peter Duchovic[1]; [1]Vipo A.S.

The aim of our research was the preparation of skin protein-based biopolymers, particularly collagen, for the application in fertilizers. The biopolymer application will contribute to an increased utilization of the domestic renewable resources. Collagen was prepared from chrome tannery waste by a dechromation technology with no oxidation to the carcinogenic Cr6+ and tested as a modifier in fertilizers with biostimulation effect. The matrix of granulated fertilizers prepared with the use of crosslinked plastified collagen will ensure extended regulated time releasing of the effective substances from the matrix, which will considerably improve the germinability and the total condition of the plants. The existing and widely used inorganic fertilizers do not ensure this regular releasing of the effective biogenic substances and trace elements. Collagen hydrolysate (water solutions and dry powder forms) has proved useful as a binder for granulates and pellets in granulated fertilizers.

The Use of Fired Roof Tile and Brick Wastes in Stoneware Bodies as Alternative Raw Materials: Munevver Caki[1]; Bekir Karasu[2]; *Selvin Yesilay*[3]; Rahmi Imrak[1]; Canbora Bayraktar[1]; [1]Anadolu University, Faculty of Fine Arts, Department of Ceramic Arts; [2]Anadolu University, Faculty of Engineering and Architecture, Department of Materials Science and Engineering; [3]Anadolu University, Faculty of Fine Arts, Department of Glass

In this study, the utilization capability of the wastes taken from a commercial roof tile and brick factory has been investigated in the production of stoneware bodies which can be formed by slip casting. At the first stage, X-ray fluorescent (XRF) and X-ray difraction (XRD) analyses of solid wastes were performed. Depending upon the results, body recipe with the optimum casting concentration was adjusted. The bodies obtained from prepared slips were fired at 1160°C as glazed and unglazed form. Then, they were undergone certain tests in order to determine their firing shrinkage values, water absorption levels and optical parameters. X-ray diffraction analysis was conducted and microstructure of the bodies were examined by a scanning electron microscope (SEM). Consequently, it was concluded that fired roof tile and brick wastes could be utilized in both glazed and unglazed stoneware bodies.

Recovery of Hexavalent Chromium Using Electrochemical Reactors Provided with Ceramic Diaphragms: *José García-Antón*[1]; Valentín Pérez-Herranz[1]; José Guiñón[1]; Henry Reyes[1]; [1]Universidad Politécnica de Valencia

The majority of chromium electroplating operations employ Cr(VI)-based baths. During these processes, Cr(VI) is reduced to Cr(III). Besides Cr(III) other undesirable impurities are present such as iron, copper and nickel. The build-up of the impurities limits the lifetime of the plating solutions. Since the disposal of spent chromic acid baths is expensive and can cause significant environmental degradation, there is increasing interest in finding ways to regenerate waste chromium liquors. In this work, an electrolytic cell separated by microporous ceramic diaphragms was used to regenerate chromium plating solutions. The effect of the ceramic diaphragm structure parameters, such as porosity and pore size, on the performance indicators of the electrochemical reactor (fractional conversion, current efficiency, product yield, specific energy consumption) was investigated. The fractional conversion, the product yield and the current efficiency increased and the specific energy consumption decreased with the decrease in porosity.

A Liquidus Temperature Model of High Alumina Blast Furnace Slags: Yuhua Li[1]; Yuanchi Dong[1]; *Liang Yu*[1]; [1]Anhui University of Technology

High alumina slag, with alumina normally more than 15 pct, is encountered with blast furnaces in China because of high alumina/silica ratio in iron ore as well as sinter and high ash content in coke for cost reason. High alumina slags generally have high viscosity and high liquidus temperature leading to higher slag volume and thereby, furnace productivity. In the present work, liquidus temperature of high alumina slags, based on Meishan factory, Baosteel China, have been investigated. A liquidus temperature model was introduced in the present work based on basic physical chemistry theory and focused on the chemical composition area used in Meishan factory(pct): Al2O3 from 14 to 17.5 and MgO from 8 to 12, so that the blast furnace slags can be designed for optimum blast furnace performance.

Opportunity Study to Pick the Right Biogas Fired CHP Plant in Romania: *Carmen Albulescu*[1]; Mihnea Ionita[1]; Albert Smand[2]; [1]AMDInitiative srl; [2]Agro Low Lands srl

The purpose of this work is to explore the opportunity to invest in a biogas fired CHP (Combined Heat and Power) Plant in Romania. Generally, a biogas CHP technology means a series of coherent process operations, to transform biomass in energy (electric and heat), via fermentation process to obtain biogas (crude methane). There are different plant designs and the question is "how to pick the right cogeneration technology". The RIGHT ANSWER means a CORRECT EVALUATION of several criteria: -location (available area, raw materials sort, raw material and energy transport distance and solutions, environmental limitations) -market request (quality and quantity of energy, organic fertilizer technology (know-how specification) -financial reasons (plant scale, technical solution and equipment cost)Based on these criteria, starting with a general project design, the report will choose the best solution to develop a biogas CHP plant, in specific financial, location and technical conditions, in Eastern Romania.

The Recovery Rare and Precious Metals from Tailings of Enrichment Ore and Placer Deposits of Gold: *Irina Yakubovich*[1]; Anatoly Yakubovich[2]; Konstantin Yankevich[2]; [1]Leningrad State Pushkin-University; [2]North-East State University

Now in gold mining areas of Russia there is a sharply problem of recycling of toxic waste products – tailings of enrichment ore and placer deposits of gold. It's widely distributed in connection with absence of ranges for warehousing and a burial place of waste products of mining industry practice of their export on the non-authorized dumps that represents growing danger to environment. The tendency of accumulation of toxic substances in soils near to sources of industrial emissions and transport is kept; volumes of waste products of manufacture and consumption annually stably increase. The existing problem of accumulation of toxic waste products is connected to high potential risk for ability to live of the population and biosphere as a whole and demands the immediate decision.That means development of technologies on recovery rare and precious metals from tailings of enrichment ore and placer deposits of gold is represented expedient.

Application Heat Pumps for Waste Energy Utilization in Sulfuric Acid Production: *Milorad Cirkovic*[1]; Milance Mitovski[2]; Dragana Zivkovic[3]; Vlastimir Trujic[1]; [1]Mining and Metallurgy Institute Bor; [2]TIR Bor; [3]University of Belgrade, Technical Faculty Bor

In this article, it is analysed the possibilitis and the effects utility waste energy of process sulfuric acid production in the existing technical-technological conditions. The utility second process energy, reduction the fuels consumption, reduction environment pollution and its effects are shown, too. High heat quantity is produced as the result of exothermal reactions in

the production process of sulfuric acid in Bor. A part of this heat is sufficient for the process development, and significant part of this heat presents low-temperature heat energy that is irretrievable lost. Investigations were carried out based on production of 485 t of monohydrate/day of sulfuric acid. By recovery of this heat quantity for heating purposes, about 20.000 – 25.000 t of coal/year would be saved, what would significantly improve the power efficiency of the smelter copper production.

High Temperature Gasification Using Plasma Technology: Javier Antoñanzas[1]; Juan Carlos Múgica[1]; *Lourdes Yurramendi*[1]; [1]INASMET-Tecnalia

The gasification of wastes containing an organic fraction is usually performed at low-medium temperature using different kind of catalysts. The off gas obtained is a mixture of carbon oxides, mainly carbon monoxide, and hydrogen and can be used for different energetic applications. The main problem is the production of tars in the off gas that has to be separated from the valuable gas flow and, finally, treated separately. An interesting alternative is the partial or total treatment of organics at high temperature. In this case, the off gas contains a higher content of hydrogen and elemental carbon as particulate matter. The energetic source to obtain a temperature in the range of 1,000 - 1,200ºC is obtained by a plasma torch. In order to make de process attractive, an important issue to be considered is to commercialize the carbon obtained for different industrial applications.

Particle Size and Morphology of MA-MOX Precursor Powders: *Troy Nothwang*[1]; Angelique Neuman[1]; Charles Davis[1]; Stewart Voit[1]; Michael Lopez[1]; Anthony Martinez[1]; [1]Los Alamos National Laboratory

One of the thrust areas for the Global Nuclear Energy Partnership (GNEP) program is the development of actinide bearing fuels for transmutation in a fast reactor. Mixed Oxide (MOX) fuel has an extensive fast reactor irradiation history and thus is being considered for use as a baseline composition from which minor actinides (MA) can be incorporated for use as a transmutation fuel. This study involves characterization of precursor powders and pellets to be inserted into the Advanced Test Reactor in Idaho. These pellets will have three compositions: one standard MOX composition, $(U_{80}Pu_{20})O_{1.98}$, and two compositions of MA-MOX with oxygen to metal ratios (O/M) of $(U_{75}Pu_{20}Am_3Np_2)O_{1.98}$ and $(U_{75}Pu_{20}Am_3Np_2)O_{1.95}$. The precursor powders, which consisted of, highly enriched uranium oxide, depleted uranium oxide, neptunium oxide, americium oxide, and plutonium oxide, were characterized using a field emission gun scanning electron microscope (FEG-SEM) for particle morphology, size, and size distribution prior to pellet production.

Solar Pyro-Metallurgical Recycling of Carbon Dioxide - Water [Soda Reactants]: *Neale Neelameggham*[1]; Milind Deo[2]; [1]US Magnesium L.L.C.; [2]University of Utah

The mixture of carbon dioxide and water vapor - called Soda [as in carbonated water] can be converted to easily stored transportation fuels. Earlier papers on Soda- fuel metallurgy noted that this conversion is endothermic requiring energy. Reduced state metallic elements - preferably the alkali, alkaline earth elements, or aluminum can act as an oxygen carrier. Availability of such a combination in commonly landfilled waste materials is shown. Plant based wastes which are normally composted form a better controlled reagent. The endothermic energy can come from solar energy. This paper describes possible reactor designs, which can accommodate this conversion effectively using recovered carbon dioxide from flue gases.

Renewable Energy and Amorphous Silica Obtained from Rice Husk Combustion in a Fluidized Bed Reactor: Juan Martínez[1]; Tatiana Pineda[1]; Janaína Junkes[2]; *Dachamir Hotza*[2]; [1]Universidade Pontificia Bolivariana; [2]Uiversidade Federal de Santa Catarina

The rice husk combustion in a bubbling and atmospheric fluidized bed reactor was investigated. The results showed the technical viability of producing both heat and amorphous silica from a renewable energy source. This paper presents the rice husk ash characterization employing the techniques of X-ray diffraction (XRD), X-ray fluorescence (XRF), and scanning electron microscopy (SEM) among others. After combustion, a rice husk ash containing 93% amorphous silica and <3% unburned char was produced. Methods usually applied to fixed bed considering external sources of energy and high reaction times were employed. Thus, the potential of this type of reactors with respect to speed, continuity and self-sufficiency energy of the process was shown.

Comparison of Gaseous Emissions Derived from Solid Waste Management System of Two Cities from RS-Brazil: *Diosnel Rodriguez Lopez*[1]; Adriane Rodriguez[1]; [1]Universidad de Santa Cruz do Sul

The aim of this work is to present a comparison of the atmospheric emissions derivatives from solid waste management systems of two cities in the State RS-Brazil with different size and waste management systems. The comparison was carried out using the Life Cycle Inventory tool. One of the considered cities was São Luiz Gonzaga, whose waste management system is based on collection, transport and final deposition on a dump. The second city chosen was Santa Cruz do Sul, whose waste management system is based on collection, transport, selection and recovery of valued waste and final disposal on a sanitary landfill. The results of this work showed that small cities, with an inadequate final waste deposition system, can emit on the atmosphere higher amounts of pollutants with global warming potential than bigger cities, whose residues are landfilled in an adequate form.

Processing of Plastic Waste Mixture: Study of Mechanical and Morphologycal Properties: Larissa Montagna[1]; *Ruth Marlene Santana*[1]; [1]Santa Cruz do Sul University - UNISC

Since the industrial revolution, plastic products sector has growing bigly, however this fact presents as consequence the increase of municipal plastic waste (MPW). The aim of this work is to develop polymer mixture from MPW with the addition of rubber tire (TR) post use and to study the mechanical and morphologycal properties. The polymer mixtures Polypropyle/High impact polystyrene/TR (PP/HIPS/TR), where rate weight TR used was 10, 20 and 30% and with three size particles (500, 710 e 1000 µm). The specimen test were obtained by injection molding. Preliminary results of mechanical properties showed that the increase of TR influence in a reduction of the flexural and tensile resistance. Results by scanning electronic microscopy on the fracture surface of mixtures PP/HIPS/TR showed a better interaction of TR particle with HIPS than with PP. Also, the presence of microcavitations were observed, characteristic in PP/HIPS blends, favouring in the increase of its opacity.

Preliminary Studies on Pyrolysis and Gasification of an Argentine Sub-Bituminous Coal: *Horacio Nassini*[1]; Georgina De Micco[1]; Gastón Fouga[2]; Ana Bohé[1]; [1]Comisión Nacional de Energía Atómica; [2]Consejo Nacional de Investigaciones Científicas y Técnicas

Coal is the most abundant fossil fuel in the world and it will continue to dominate the energy supply in the future. As there are increasing environmental concerns directed towards using coal in combustion devices, cleaner coal technologies have been developed to minimize the pollutant emissions. Coal gasification is one of the most important and versatile clean coal technologies for power generation and production of chemicals, liquid fuels and hydrogen. Gasification process is a two-step process where the volatile components of coal are firstly released, leaving a solid char that is further gasified in presence of oxygen, CO2, and steam. In this work, preliminary studies on the pyrolysis and gasification of an argentine sub-bituminous coal are presented. Pyrolysis experiments at low and high heating rates were carried out using a fixed bed reactor and a drop tube furnace, respectively, while the gas reactivity of produced chars was determined by thermogravimetry.

Waste Conversion and Re-Utilization in Postwar Liberia: *Moses Eben*[1]; [1]Center for Environmental Education and Protection (Liberia)

This paper will briefly mention the history of Liberia, its war situation and its ramifications with regards to waste produced as a result of the war. A brief environmental situation will also be described. The prospects of re-cycling and applying Clean Technology in Liberia will be expounded mentioning whether its sustainability is applicable; its environmental perspective is environmentally sound. Similarly, the economic and developmental advantages and disadvantages of waste conversion and re-utilization in Liberia will be enumerated. Waste conversion and re-utilization in Liberia application's with regards to climate change, gender, and millennium

development goals will be reviewed. The paper will conclude will a personal perspective of whether waste conversion and re-utilization in Liberia is practicable, economically viable, developmentally and environmentally sound.

Problems and Prospects of Ecological and Technological Development of Hydrocarbon Resources Processing in the Arctic: *Tsukerman Vyacheslav*[1]; Ludmila Ivanova[1]; [1]Institute for Economic Studies

The potential of hydrocarbon resources in the Arctic oil and gas provinces is enormous. Oil and gas constitute the basis of mineral resource base of the shelf zone of the Russian Arctic; summary volume of hydrocarbons exceeds 100 billion tons of conventional fuel. Only in the Shtockman gas condensate field in the Barents Sea explored balance reserves equal to 3.2 trillion m3 of gas. It is necessary to establish a special regime of nature management in the Arctic. Environmentally oriented economic activities should be more actively stimulated. The Energy Strategy plans that starting from 2010 in the Barents and Pechora Seas up to 10 million tons of oil and 50 billion m3 of gas will be extracted, reaching the level of 30 million tons of oil and 130 billion m3 of gas in 2020. This task cannot be solved without intensification of geological exploration on the continental shelf.

Post-Consumer Pet Recycling: Selective Flotation Separation of PVC in the Cleaning Process: Anderson Müller[1]; *Ruth Marlene Santana*[1]; [1]Santa Cruz do Sul University - UNISC

The great problem for the success of the recycling process of polyethylene terephtalate (PET) is the presence of polyvinyl chloride (PVC) as a pollutant, which presents negative influence on the final product of recycled PET (dark stains and PET degradation). In this study, the aim is to evaluate the efficiency of separation of PVC from PET/PVC mixtures troughout the using of surfactant products. The PET in use comes from post-consumer drinking bottles, it is grinded and washed in two cleaning solution NaOH and detergent solutions for with and without heating. Then was submitting the samples into a nonionic surfactant solution (ethylene glycol - EG) for the selective flotation separation. The flakes were analyzed throughout physical-chemical characterization. Previous results demonstrated that NaOH is efficient in the plastic cleaning; however it has a large influence on PET degradation. The EG surfactant showed a great performance in the separation of PVC from PET.

Experimental Design to Maximize Granite Sawing Waste Content in Ceramic Tiles: *Romualdo Menezes*[1]; Bartolomeu Silva[1]; Lisiane Santana[1]; Gelmires Neves[1]; Heber Ferreira[1]; Helio Lira[1]; [1]Universidade Federal de Campina Grande

The use of experimental design to the study of mixtures has found a wide range of applications, even in laboratory scale or in industrial development works. The aim of this work was to maximize granite sawing waste content in ceramic tiles using experimental design. Based on the raw materials, specific formulations were developed using the experimental design. The raw materials were mixed and sample bodies were produced using uniaxial pressing. The sample bodies were fired and characterized in terms of water absorption, mechanical strength and X-ray diffraction. Regression models were adjusted relating the water absorption and mechanical strength with the amount of raw materials. The results showed that the methodology of experimental design maximize the content of wastes incorporated in ceramic tiles formulations. Formulations containing up to 40% of waste can be used for the production of ceramic tiles.

Incorporation of Sanitary Ware Wastes in Structural Ceramics: *Shirley Cosin*[1]; Guillermo Martín-Cortés[1]; Jorge DiRito[2]; Francisco Valenzuela-Díaz[1]; [1]Escola Politecnica da Universidade de Sao Paulo; [2]Porto de Areia Itabrás

The Jundiaí River recovery is a priority. There is a Municipal waste water treatment plant that deals with practically 100% of the Jundiai City sewer. But, the river is very contaminated because effluents without a suitable treatment are deposited in it. This paper describes the area of Itabrás in the edges of the Jundiaí River and the great environmental impact works that are being made in the Itabrás sand and common clay deposits. Those works consist in the separation of solid waste from the river, and its distribution to recycling companies, recoups the degraded areas, using not contaminating industrial proper wastes, incorporation of industrial and agricultural wastes in common clays for structural ceramics fabrication, and reforestation activities. The main goal of this paper is to show those activities which contribute to improve the health of the river preventing floods and collaborating with the restoration of the Jundiai river area.

Expanded Polystyrene Wastes Recycling by Using Natural Solvents and Supercritical CO_2 for Solvent Recovery: Teresa Garcia[1]; *Juan Francisco Rodriguez*[1]; Antonio de Lucas[1]; Ignacio Gracia[1]; Gema Duque[1]; [1]University of Castilla La Mancha

The amount of waste of Polystyrene (PS) foams is increasing in last years due to their use in isolation, protecting, and storing many different food products. Conventional methods of recycling such as crushing and shrinking by heated air or frictional heat have the disadvantages of molecular degradation, resulting in a reduction of the quality of the recycled polymer. Solvent extraction is one of the cheapest and more efficient processes for polystyrene recycling but in the solvent recovery process thermal molecular degradation it is produced. In this way, CO_2 supercritical technology appears like an interesting alternative process for the elimination of solvents. This work proposes a global process to polystyrene recycling in two steps: a polystyrene dissolution with suitable solvents followed by solvent elimination by supercritical fluids. In order to develop a "green process" the constituents of essential oils, d-limonene, terpinene, phellandrene, are selected as the most appropriate solvents.

Nontraditional Reclamation Methods in North Bohemia Region: *Vladimir Cablik*[1]; Nikolas Mucha[1]; Katerina Cechlova[1]; Peter Fecko[1]; [1]VSB - Technical University of Ostrava

Waste water treatment before its discharge into water courses is a vital precondition of maintaining the quality of ground and surface water sources. It is necessary to minimize the impact of any inorganic contaminants, dispose of their effects or at least reduce them. Adsorption technologies are one way how to remove such substances from water. Those technologies of water purification assert themselves especially in cases when biological treatment is not suitable or is insufficient. Among effective sorbents there are claystones and bentonites. Claystones and bentonites from the North Bohemian and Sokolov Basins, which are minor raw materials in the course of extraction of brown coal, can be used as sorbents. The advantage of minor raw materials is their natural origin, the fact they are cheap and abundant. Moreover, they improve economic effectiveness of mining and as they are processed they are not dumped, which means the environment is not strained.

Basic Aspects of Ecological and Economical Industrial Waste Material Usage: *Miroslav Svoboda*[1]; Jaroslava Ledererova[1]; Petr Sulovsky[1]; Michaela Suchardova[1]; [1]Research Institute of Building Materials, JSC.

Thinning reserves of natural raw materials necessitate increased degree of waste materials recycling. The building industry offers a range of technologies enabling incorporation of industrial wastes into building materials for construction elements in an economically acceptable way. Our research is focused on finding appropriate technologies for specific groups of industrial waste materials (IWM). Researched IWM involve coal combustion residues (CCR), sludges, metallurgical slags, and various other wastes. Many of them contain increased amounts of toxic elements that can under certain conditions get released. In order to prevent it, each specific IWM requires to find the technology that best ensures that binding of the toxic elements in the building matter are fixed in the long term.

Solvent Extraction of Pt(IV) from Acidic Chloride Solutions Using Alamine 336: *Jin-Young Lee*[1]; Rajesh Kumar[1]; Joon Soo Kim[1]; Jeong-Soo Sohn[1]; [1]Korea Institute of Geoscience and Mineral Resources

Liquid-liquid extraction (LLE) studies of tetravalent platinum from acidic chloride solutions have been carried out with Alamine 336 as an extractant diluted in kerosene. Increase of acid concentration decreases the percentage extraction of metal where as increasing of extractant concentration increasing the metal extraction it indicates the cation exchange mechanism. The addition of salts the extraction behavior various with the salt concentration. Increase of temperature decreases the percentage extraction of metal indicating the

process is exothermic. The loaded capacity of extractant and extraction behavior of associated elements was studied.

Metallographic Evaluation of a Breached Container: *Ramiro Pereyra*[1]; Daniel Schwartz[1]; Darryl Lovato[1]; [1]Los Alamos National Laboratory

During an annual inventory of nuclear material a container, containing PuO_2 failed. The container had been packaged for temporary storage but had been overlooked and remained in the vault for more than 23 years. Although it was determined that the failure occurred through the slip-top rim, a metallurgical evaluation was requested to help determine the integrity of the container. The depth of corrosion, measured at approximately 10 µm, did not pose a threat to the integrity of the container. However the corrosion morphology did suggest that a galvanic cell had developed between the tin and steel from the condensation of water. The morphology also suggests that the attack of the steel took place over a series of cycles due to changes of the environment within the container. This report will present optical metallography and SEM images of the container and corrosion products to support the finding of the evaluation.

A Comparative Study between Hybrid Natural/Biodegradation and Biodegradation Methods of Cyanide from Ore Waste Using Native Bacteria: *A. L. Leal-Cruz*[1]; M. T. Certucha-Barragán[2]; M. I. Pech-Canul[3]; S. Aguayo-Salinas[2]; J. L. Valenzuela-García[2]; [1]Universidad de Sonora and Cinvestav Saltillo; [2]Universidad de Sonora; [3]Cinvestav Saltillo

The aim of this research was to carry out a comparative and systematic study of the degradation of cyanide by hybrid natural/biodegradation and biodegradation methods using a mixture of Pseudomonas sp and Bacillus megaterium native bacteria. Bioreactors consist of filled columns with contaminated ore containing 100 ppm of total cyanide. In the biodegradation tests a mixture of bacteria was inoculated into the biodegrading solution. Results of cyanide degradation show a similar asymptotic behavior in both the hybrid (opened system) and biodegradation (closed system) methods; however, for the same period of time (72 h) the permissible maximum levels (1-2 ppm of cyanide) are only attained in the closed system. While in the closed system the cyanide levels are reduced from 100 to 1.5 ppm, in the open system, cyanide decreases from 100 to 2.4 ppm.

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The Scientific Society of the Mineral Wealth Technologists *(Greece)*

Program At-A-Glance

REWAS 2008

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