Lead-Zinc 2000 Symposium & The Fourth International Symposium on Recycling of Metals and Engineered Materials

	Sunday-October 22	Monday-October 23		Tuesday-October 24		Wednesday-October 25	
	PM	AM	PM	AM	PM	AM	PM
Mezz-anine Foyer Chartiers Rivers	Registration 12:00NOON-6:00PM	Registration 7:00AM-5:00PM Slide Preview 7:00AM-5:00PM Authors Coffee 7:30AM-8:30AM		Registration 7:00AM-5:00PM Slide Preview 7:00AM-5:00PM Authors Coffee 7:30AM-8:30AM		Registration 7:00AM-10:00AM Slide Preview 7:00AM-5:00PM Authors Coffee 7:30AM-8:30AM	
LeBateau	Welcoming Reception 6:00PM-8:00PM	***Recycling*** Consumer Battery Recycling	***Recycling*** Aluminum By-Product Recovery	***Recycling*** Precious Metals Recycling	***Recycling*** Electronics/ Plating By-Products Recycling	***Recycling*** Refractory Recycling	***Recycling*** Magnesium Recycling
Kings Gardens	Welcoming Reception 6:00PM-8:00PM	***Recycling*** Aluminum Recycling - Introduction	***Recycling*** Aluminum Scrap Recycling - I Scrap Preparation and Processing	***Recycling*** Automotive Materials Recycling	***Recycling*** EAF Dust Processing - I	***Recycling*** EAF Dust Processing - II	***Recycling*** EAF Dust Processing - III
Kings Terrace			***Recycling*** Secondary Zinc				
Brigade		***Recycling*** General Recycling	***Recycling*** Secondary Copper, Nickel, and Cobalt - I	***Recycling*** Secondary Copper, Nickel, and Cobalt - II	***Recycling*** Secondary Lead - I	***Recycling*** Secondary Lead - II	***Recycling*** Spent Catalyst Recycling
Ballroom 1		***Recycling*** Plenary Session		***Recycling*** Aluminum Scrap Recycling - II Melting Technology	***Recycling*** Aluminum Dross Processing	***Recycling*** Aluminum Scrap Recycling - III Quality Considerations in Recycling	***Recycling*** Aluminum Scrap Recycling - IV Process Analysis
Ballroom 3		***Lead-Zinc*** Plenary Session Global Factors Affecting Lead and Zinc	***Lead-Zinc*** Session 2 - Modern Lead Smelting Technologies I	***Lead-Zinc*** Session 4 - Modern Lead Smelting Technologies II	***Lead-Zinc*** Session 6 - Imperial Smelting Technologies	***Lead-Zinc*** Session 8 - New Developments in Lead and Zinc	***Lead-Zinc*** Session 10 - New Electrowinning Technologies for Lead and Zinc
Ballroom 4		***Lead-Zinc*** Plenary Session Global Factors Affecting Lead and Zinc	***Lead-Zinc*** Session 3 - Zinc Operations I	***Lead-Zinc*** Session 5 - Zinc Operations II	***Lead-Zinc*** Session 7 - Zinc Electrowinning	***Lead-Zinc*** Session 9 - New Zinc Processing Technologies	***Lead-Zinc*** Session 11 - Environmental Aspects of Lead and Zinc Production

Table of Contents

Lead Zinc 2000

Fourth International Symposium on Recycling of Metals and Engineered Materials

Fourth International Symposium on Recycling of Metals and Engineered Materials Technical Program

Plenary Session

Monday AM — Room: Ballroom 1
October 23, 2000 — Location: Pittsburgh Hilton

Session Chairs: Donald L. Stewart, Aluminum Company of America, Alcoa Tech. Ctr., Alcoa Center, PA USA; James C. Daley, Daley & Associates, Phoenix, AZ USA; Robert L. Stephens, Cominco Research, Trail, British Columbia, Canada

9:00 AM Introductory Remarks

9:10 AM
Technology Commercialization in the New Millennium: Lessons from the Previous Millennium: L. M. Southwick[1]; [1]L. M. Southwick and Associates, 992 Marion Ave., Ste. 306, Cincinnati, OH 45229 USA

There is much ongoing work in research and development of new processes for the recovery and recycling of metals and other materials from various waste and scrap streams. Commercialization of such new technologies requires the bringing together and successful execution of a considerable effort involving a variety of activities. These include process conceptualization, research and development, detailed design and construction, and then plant startup and operation. Processes evolve through all of these steps by engineering due diligence, making objective and critical analyses of results, and troubleshooting processing steps to, hopefully, arrive at a sequence that has the best chance to succeed operationally and economically. After a summary review of the above steps, several processes will be described in more detail that provide mostly successful examples of the above procedures. Finally, some observations will be made on areas that will become critical in the near future to the success of new processes for wastes and residues.

9:45 AM
The Importance of Recycling to the Environmental Profile of Metal Products: K. J. Martchek[1]; [1]Alcoa, Inc., 201 Isabella St., Pittsburgh, PA 15212 USA

This introductory presentation will highlight recent efforts to quantify the positive value of recycling metals such as aluminum, magnesium, lead, zinc, nickel and copper in relation to the three pillars of "sustainable development"–environmental protection, economic development and improve social consequences. This presentation will provide an overview of life cycle assessment profiles increasingly being utilized by customers, regulators and environmental advocacy groups to holistically evaluate the environmental performance of materials and products. The environmental profiles of products containing recycled metal will be presented based on rules established by the International Organization for Standardization (ISO). Significant to the life cycle profile of metal products is the recent confirmation that recycling has the potential to reduce materials production energy consumption by 95% for aluminum, 80% for magnesium and lead, 75% for zinc, and 70% for copper. Furthermore, "metals are eminently and repeatedly recyclable, while maintaining all their properties (1)." Their durability relative to many hydrocarbon based materials enhance their life cycle performance. However, the persistence of metals when dispersed into our natural environmental makes recovery and recycling particularly important. Overall, when considering life cycle effects, recycling is critical to a sustainable future for metal products. Finally, regional and international regulations will be highlighted which will effect the efficient recovery and recycle of metals and their overall contribution to environmental protection, economic development and the enhancement of society.

Aluminum Recycling - Introduction

Monday AM — Room: Kings Gardens
October 23, 2000 — Location: Pittsburgh Hilton

Session Chair: Donald L. Stewart, Aluminum Company of America, Alcoa Tech. Ctr., Alcoa Center, PA USA

10:45 AM
UBC Recycling Complex Mass Balance: R. F. Jenkins[1]; K. G. Robertson[2]; [1]Thorpe Technologies, Inc., P.O. Box 1759, Gulf Shores, AL 36547 USA; [2]Aluminum Industry Consultant, P.O. Box 938, 1135 Hwy. 133, Hotchkiss, CO 81419 USA

This paper presents a practical approach for utilizing a computer model to determine the mass balance for a typical UBC recycling complex-starting with raw materials input, through scrap preparation, delacquering, melting, alloy adjustment and casting. This model is especially concerned with metal unit losses throughout the recycling complex with emphasis on metal losses at the melting furnace. The model also addresses the application of hardener alloys, metallurgical salts, chlorine for demagging, and reagents for acid gas emissions control. Other issues addressed are dross generation, acid gas emissions and dirt and fines to landfill. One benefit of the model is the conversion of annual production objectives to hourly production rates and resource requirements taking into account production schedules, maintenance downtime, and operations inefficiencies.

11:10 AM
Cold Cleaning and Concentrating of Non-Ferrous Dross: D. J. Roth[1]; P. G. Schirk[1]; [1]ALTEK International, 314 Exton Commons, Exton, PA 19341 USA

ALTEK has developed a processing system that can receive large pieces of dross & bath, of various metal contents, and reduce and separate these highly metallic concentrates into oxides and non-metallics. This system achieves these results without grinding the metallics into fines. Its unique feature results in the preservation of metallic unit in its largest possible size, which allows for maximum metal recoveries. The Tumbler, an ALTEK-Didion International joint development, and the ALTEK High Velocity Impacting System (HVIS) are the key elements to this process. This paper will explore the advantage of this cold cleaning system over the direct melting of the raw dross in the reduction of landfill waste. The system also works well for removal of the aluminum from bath from primary smelters.

11:35 AM

Regulatory Issues Associated with Salt Cake and Dross Processing in USA and Europe: J. N. Hryn[1]; E. J. Daniels[1]; M. Askew[2]; G. Kirchner[2]; [1]Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL 60439 USA; [2]Organisation of European Aluminium Refiners and Remelters, P.O. Box 20 08 40, Düsseldorf D-40105 Germany

This presentation addresses the changing regulatory climate towards aluminum dross and salt cake in Europe and in the United States. Although sporadic, the trend in the U.S. continues to be away from command-and-control regulation of these materials. This trend began in the early 1980s when the Environmental Protection Agency was successfully sued in court and prevented from classifying dross as a hazardous material. The situation in Europe is different. Because of Council Directive 86/61/EC from the European Commission, European Union member countries have all passed legislation that will essentially cause all salt cake and drosses to be reprocessed. The implementation date of the legislation varies from country to country: from 2001 in the United Kingdom to 2007 in Germany, France, Austria, Italy, and Spain. The European aluminum industry is urging the EC to use the approach adopted by the U.S. EPA, which declassifies the majority of aluminum drosses and salt cakes.

Consumer Battery Recycling

Monday AM — Room: LeBateau
October 23, 2000 — Location: Pittsburgh Hilton

Session Chair: Robert L. Stephens, Cominco Research, Trail, British Columbia, Canada

10:45 AM

Recycling of Mobile Phone Batteries Using the Ausmelt Catalytic Waste Converter: J. Sofra[1]; J. Fogarty[1]; [1]Ausmelt Limited, 12 Kitchen Rd., Melbourne, Victoria 3175 Australia

The mobile telecommunications sector is one of the fastest growing industries worldwide. However, increasingly stringent environmental regulations are placing pressure on manufacturers to accept responsibility for end of life products. The companies are therefore exploring avenues to recover the valuable components contained within the mobile telecommunications devices thus reducing the quantities of toxic components going to landfill. Batteries used to power the devices, are typically based on either nickel-cadmium, nickel metal hydride, or lithium ion cells. They contain toxic metals including nickel, cadmium, lithium, potassium, lead, and cobalt in a complicated arrangement of battery cells surrounded by a metals then plastic casing. The Ausmelt Catalytic Waste Converter (CWC) for waste treatment and recycling is well suited to processing all three mobile phone battery types for the recovery of valuable metals in marketable products that can be recycled to industry without turning out harmful levels of toxic emissions. Ausmelt recently demonstrated the capabilities of its CWC by continuously processing 4.5 tonnes of nickel-cadmium batteries. Using Ausmelt's pilot plant facility in Australia, the nickel-cadmium batteries were processed to produce a nickel iron sulphide (matte), a cadmium fume and a final slag which satisfied US toxicity leach test criteria and was safe for disposal to landfill. This paper explores the commercial development of the Ausmelt CWC for treating each of the three battery types in light of (a) the outcomes of the recent demonstration, and (b) the current and expected future availability of batteries for processing.

11:10 AM

Zimaval (Zinc Manganese Valorization) Technology for Recycling of Batteries and Other Complex Zinc Bearing Materials: S. Ferlay[1]; [1]Zimaval Technologies, Route de la Hoguette, Falaise 14700 France

The main purpose of the ZIMAVAL project (Label EUREKA EU1367 and LIFE ENV/F/000278) is to demonstrate industrial scale recovery and recycling of the main components of used dry batteries (zinc, manganese dioxide, mercury, and stainless steel) into high added value products. The originality of the ZIMAVAL process resides in: 1-the use of hydrometallurgy; 2-alkaline treatment implementation (highly selective) for zinc and mercury; 3-electrochemical recovery of high quality products; 4-the recycling of all the battery components (zinc, mercury, manganese dioxide, stainless steel); 5-low operating and investment costs. The process consists of physical classification, mechanical dismantling, hydrometallurgy and electrochemistry. The purpose of the demonstration plant in FALAISE (Calvados-France) is to define the technical and technological parameters of an industrial unit for the treatment of 2400 tonnes per year of used batteries.

11:35 AM

The Oxyreducer Technology–A New Technology to Recycle Metal Containing Waste: A. Antenen[1]; D. Villette[1]; [1]CITRON SA, Route des Gabions, BP 51, Rogerville F-76700 France

CITRON has developed a new process for the recycling of hydroxide sludge, household batteries, catalysts, automobile shredding residues, grinding sludge and other metal containing organic and inorganic waste. A pilot plant with a capacity of 1,000 tons per year has started operations in April 1998. In August 1999, an industrial plant became operational with an initial treatment capacity of 23,000 tons.

General Recycling

Monday AM — Room: Brigade
October 23, 2000 — Location: Pittsburgh Hilton

Session Chairs: James Daley, Daley & Associates, Phoenix, AZ USA

10:45 AM

Processing of Televisions by Mechanical Separation Techniques: Implications for Future Work in Product Design and Recycling: J. M. Krowinkel[1]; W. L. Dalmijn[1]; [1]Delft University of Technology, Faculty of Applied Earth Sciences, Dept. of Raw Matl. Tech., Mijnbouwstraat 120, 2628 RX Delft, The Netherlands

A recycling concept of end-of-life televisions starting with shredding will produce a complex material mixture, very heterogeneous in size, shape and degree of liberation. Basically all materials in television scrap are valuable, which means that recovery is important for either economic, environmental or sustainability reasons. However glass, plastics and metals are the materials with the highest potential for recovery. Non-magnetic materials from shredded television sets can be separated into three characteristic size fractions that need further separation for a high value-added recycling of the materials. This study investigated the potential of physical separation of these size fractions into valuable material streams using polyseparator, eddy current separator, dry and wet shaking tables and electrostatic separator. An overall mass balance of the mechanically processed televisions was calculated. Evaluation of the produced material fractions showed that heterogeneity in particle shape and size together with the presence of unliberated materials caused sever difficulties in separation when exclusively based on mechanical techniques. The results indicate that a certain degree of dismantling is necessary to achieve products of appropriate quality in physical separation. In order to improve recycling of electronic scrap through design for recycling cooperation between the electronics industry, the manufacturers and the recyclers of electronic goods is necessary.

11:10 AM

Recycling Metals Using the MOCVD Process: D. S. Terekhov[1]; M. O'Meara[1]; [1]CVD Manufacturing, Inc., 35 Kenhar Dr., Toronto, Ontario M9L 1M7 Canada

Metal Organic Chemical Vapour Deposition (MOCVD) is used in the production of computer circuit boards and metal shapes in nickel, gold, copper, cobalt, etc. All varieties of MOCVD use the decomposition of a vapour of organometallic compounds to produce different forms of ultra-pure metals, or alloys. CVD Manufacturing's proprietary MOCVD process has been adapted and developed to produce commercially ultra-pure metal shapes, metal powders, and metal foams. Therefore, it is a purification process. The typical process has three steps. First, a volatile metal organic compound is produced from volumetrically contaminated metals, metal oxides, etc. Typical feed materials are metal powders, ores, concentrates, or a slurry of metals and contaminants. Secondly, the volatile metal organic compound is purified by fractional distillation. Thirdly, the purified metal organic compound is decomposed into different forms of ultra-pure metals, such as net shapes, powders, or metal foams. A mixture of metals can be purified either by the selective production of volatile materials, or a separation can be achieved during the second step, in the fractional distillation stage. The purification and recycling of metals by the MOCVD process will be discussed, particularly with regard to nickel, aluminum, gold, the platinum group and other metals.

11:35 AM

An Improved Non-Conventional Method for Obtaining Nuclear Pure Uranium Oxides and Uranium Tetrafluoride from Actual Mill Strip Solution: L. A. Guirguis[1]; H. K. Fouad[1]; [1]Nuclear Materials Authority, 11 Ali Abn Radwan St., El Marghani, Heliopolis, Cairo, Egypt

The starting mill strip solution for this study is an ammonium uranyl tricarbonate solution pH 8.2 containing 20g uranium/liter, after a DEPA/TOPO extraction process from sulfuric acid leaching liquor. To the first portion of the concentrated acidified strip solution, hydrofuoric acid is added at 95°C in reduced condition to obtain uranium tetrafluoride. The second portion of the uranyl carbonate strip is subjected to a precipitation step by admixing 0.3 volume of non-solvent precipitating agent such as acetone per volume of uranium. Uranium oxide (U_3O_8) is obtained from this precipitate by calcination for half an hour at 800°C in air. The third portion of the strip solution is neutralized to a pH 6.5 with sulfuric acid to precipitate iron and contaminants. The solution is further acidified to a pH 1.85 with continuous air bubbling to remove CO_2, followed by H_2O_2 precipitation at pH 3.5 to obtain uranyl peroxide. The latter is reduced by stannous chloride to obtain uranium trioxide dihydrate $UO_3.2H_2O$. Identifications, characterization and purity of these products are carried out by complete chemical analyses, scanning electron microscope study, tap density determination, X-ray diffraction and infrared spectroscopic investigations. The achieved results agreed well with that of the published data for these nuclear grade purity products.

Aluminum By-Product Recovery

Monday PM — Room: LeBateau
October 23, 2000 — Location: Pittsburgh Hilton

Session Chairs: John Hryn, Argonne National Laboratory, Argonne, IL USA; John W. Pickens, Alumitech, Inc., Streetsboro, OH USA

2:00 PM

Electrodialysis Technology for Salt Recovery from Aluminum Salt Cake Waste Brines: G. K. Krumdick[1]; D. J. Graziano[1]; J. N. Hryn[1]; [1]Argonne National Laboratory, Energy Sys. Div., 9700 S. Cass Ave., Argonne, IL 60439 USA

Electrodialysis technology is being developed to recover salt from brines generated in the commercial process for recycling aluminum salt cake. Salt cake, a waste stream from the aluminum industry, contains aluminum metal, salt (NaCl and KCl), and nonmetallic impurities. After grinding and screening to separate out aluminum metal, salt cake solids are leached in water and filtered to recover a nonmetallic product (NMP). The filtered brine is then processed in an evaporator to separate salt and water. Researchers at Argonne National Laboratory identified electrodialysis as a promising process for salt recovery that may be less cost prohibitive than evaporation. Laboratory experiments suggested that the cost advantage of electrodialysis could be further improved through the selection of membranes to reduce power consumption and by operating with a differential pressure to reduce water transfer across the membranes. A large-scale electrodialysis pilot plant has been designed and constructed to verify laboratory results and the commercial viability of the process. Experiments are currently underway to characterize the effects of differential pressure, concentration difference, and current density on the water transfer and current efficiency of electrodialysis operations with concentrated brines.

2:25 PM

Reclaiming Salt Flux From Aluminum Salt Slag Wastes Process Design–Product Performance: R. M. Russell[1]; J. Sweeney[2]; [1]RMR Engineering, LLC , Nashville, TN USA; [2]Tennessee Aluminum Processors, Inc., Mt. Pleasant, TN USA

The disposal of Aluminum slag wastes continues to challenge an otherwise environmentally beneficial and highly desirable industry-Aluminum Recycling. Slag wastes contain soluble salts that can be reused in aluminum smelting. Reclaiming salt is a logical first step in eliminating slag waste. Reclaiming salt flux has been conducted on a limited basis in the United States for reasons of economy. Practical methods and rising landfill tipping fees will increase the number of plants which opt to recover salts from slag wastes. The authors share their experiences in the design, operation and startup of a commercial scale flux reclamation plant operated by Tennessee Aluminum Processors at Mt. Pleasant, Tennessee. This paper identifies three elements that allow practical operations: Minimizing Evaporator Heat Duty; Simplifying Evaporator Operations; Potassium Chloride Fortification of the Recycled Salt.

2:50 PM

Eddy Current Separation of Aluminum Smelting By-Products: J. Y. Hwang[1]; R. C. Greenlund[1]; M. Jeong[1]; A. M. Hein[1]; D. C. Popko[1]; R. Peterson[2]; R. McChesney[3]; [1]Michigan Technological University, Instit. of Matls. Process., 309 Minerals and Matls. Eng. Bldg., 1400 Townsend Dr., Houghton, MI 49931 USA; [2]IMCO Recycling, 397 Black Hollow Rd., Rockwood, TN 37853 USA; [3]Down Stream Systems, Inc., 7500 Folsom Auburn Rd., #1807, Folsom, CA 95630 USA

MTU is conducting a study to recycle and reuse the aluminum waste generated from various segments of the aluminum smelting industry. This study is supported by the U.S. Department of Energy and Industry. A portion of this effort is to determine the operating efficiencies of Eddy Current Separation, comparing separating characteristics of white and black dross. The results of this effort will be presented here.

3:15 PM Break

3:45 PM

Aluminum Plasma Dross Treatment Process and Calcium Aluminate Production: Closing the Loop with No Residue: R. Breault[1]; D. Guay[1]; G. Dubé[1]; D. Legault[2]; R. Morin[2]; K. Annett[2]; J. Bonneau[2]; [1]Alcan International Limited, Arvida Rsch. and Dev. Ctr., Jonquiere, Quebec G7S 4K8 Canada; [2]AlumiCamInc, Mazarin Mining Corporation, 2189 Blvd. Caouette Sud, Thetford Mines, Quebec G6G 8A4 Canada

The total recycling of all the constituents present in aluminum dross is now an industrial reality for Alcan. This is made possible by the combination of two patented processes: the Alcan plasma dross treatment process, operating since 1990 at its Guillaume-Tremblay Works, and the calcium aluminate fabrication process, operating at AlumiCa's new plant in Thetford Mines. The latter process uses the total non-metallic content of the dross, thus rendering possible the complete recycling of aluminum dross. After describing the plasma dross treatment process, this paper will present the calcium aluminate process and how both processes contribute to close the recycling loop. The characteristics of Noval™ by-product will also be described as well as how they contribute to make a calcium aluminate with chemical and physical properties that are highly sought after. This calcium aluminate, produced by AlumiCa, is marketed under the trade name Kwikflux®. AlumiCa's total production is presently sold to a number of steel plants worldwide.

4:10 PM

Assuring the Benefits of Aluminum Recycling: Engineering Economical Environmental Solutions to the Issues of Black Dross and Saltcake: J. W. Pickens[1]; [1]Alumitech, Inc., 10380 Route 43, Streetsboro, OH 44241 USA

The recycling of industrial wastes and by-products is an important component of ecologically responsible industrial management. Converting waste streams into value-added products or material and energy resources with a profit margin assures the continued viability and practice of recycling. The recycling of aluminum stands out as one of the best examples with major economic and environmental benefit. However, the benefits are compromised by landfilling of black dross and salt cake, waste streams produced from within the recycling process itself. This paper reviews Alumitech's strategy and progress in establishing a tertiary aluminum industry based on closed-loop recycling of black dross/saltcake; one which does not compete with the primary and secondary aluminum industries, but rather serves their needs to ensure the continued economic benefits of aluminum recycling and elimination of environmental liability associated with landfilling of black dross/saltcake. Alumitech has made significant progress toward that goal in operation of its new recycling facilities in Cleveland where recovered aluminum and nonmetallic residue from salt based drosses is being converted into commercial products, eliminating the landfilling of the greatest portion of dross/saltcake. The economic strategy for recycling saltcake and its progressive achievement is reviewed.

4:35 PM

R&D on Treatment and Recycling of Dross Residue: M. Tougo[1]; M. Tokunoh[1]; F. Chiba[2]; T. Kisaragi[3]; [1]Mitsubishi Aluminum Co., Ltd., 3-3, Shiba 2-chrome, Minato-ku, Tokyo, 105-8546 Japan; [2]Showa Aluminum Co., Ltd., 3-6-5 Iidabashi, Chiyoda-ku, Tokyo, 102-8111 Japan; [3]Takayasu Kisaragi, Sumitomo Light Metal Industories, Ltd., 5-11-3, Shinbashi, Minato-ku, Tokyo 105-8801, Japan

We have about 200,000 tons/year of dross residue produced after the collection of aluminum from the dross generated during the aluminum remelting process. 130,000 tons of the dross residue is used as a steel deoxidant or a cement material, and the remaining 70,000 tons is abolished and buried in the ground at authorized places. The dross residue is increasing along with the increase in the aluminum production. This situation will grow more serious with a large amount of aluminum window sashes which have been mass-produced since 60's and will return before long as scraps. Our effort is being directed to the development of technologies which enable the dross residue to be recycled and reused for some purposes such as road aggregates, refractories and others, in such a way as to comply with the social requirement which gives priority to the recycling industry, as well as to the environmental preservation.

5:00 PM

Conversion of Aluminium Industry Wastes into Glass Ceramic Products: G. Balasubramanian[1]; M. T. Nimje[1]; V. V. Kutumbarao[1]; [1]Jawaharlal Nehru Aluminium Research Development and Design Centre, Analy. Rsch., Nagpur, 440 023 India

Wastes from the aluminium industry such as red mud from the alumina refinery, fly ash from the captive power plant and spent pot lining from the smelter, have been successfully converted into glass-ceramic products. The process involves addition of a small quantity of glass former along with traces of nucleating agents to aid crystallization, to a specific mixture of red mud, fly ash and spent pot lining, followed by melting at around 1300°C and vitrification by cooling. The resultant glass is then converted into a glass- ceramic by a suitable heat treatment at around 700-750°C. The glass-ceramic products show excellent wear resistance, besides possessing an aesthetic appearance. The major application foreseen for such products is as decorative tiles in the building industry.

Aluminum Scrap Recycling - I
Scrap Preparation and Processing

Monday PM	Room: Kings Gardens
October 23, 2000	Location: Pittsburgh Hilton

Session Chairs: Ray D. Peterson, IMCO Recycling, Inc., Rockwood, TN USA; Jan H.L. van Linden, Recycling Technology Services, Edgewood, PA USA

2:00 PM

Aluminum Scrap Supply and Environmental Impact Model: P. R. Bruggink[1]; [1]Alcoa Technical Center, 100 Technical Dr., Alcoa Center, PA 15069 USA

A quantitative tool has been developed to assess the impact of changes in recycling rates on the environmental impact of aluminum supply. It has been applied to the USA to forecast sources of aluminum scrap and to examine the impact of an increase in Old Scrap recovery on the USA supply system and the subsequent effect on the Life Cycle Impact of aluminum supply. The reported data for primary, secondary and import/export supply and product shipments for aluminum in the USA show a fairly good balance between supply and demand on average over the years. Therefore, it is reasonable to use the data, along with published estimates of average product lives, recycling rates and recoveries to draw conclusions about future aluminum scrap generation and recovery. The Life Cycle Impacts of increasing postconsumer recovery rates to recover an additional 450,000 MT/yr (1 billion lb/yr) has been estimated using the model. The spreadsheet model upon which this work was based was developed in U.S. Customary units. Converting the figures to Metric units would have required converting the entire model and rebuilding the figures. I have chosen to leave the figures in U.S. Customary units. I apologize for any inconvenience this may cause.

2:25 PM

Continuous Measurement of UBC Decoating Efficiency: W. D. Stevens[1]; G. Riverin[1]; C. Simard[1]; [1]Alcan International International, Arvida Rsch. and Dev. Ctr., P.O. Box 1250, Jonquière, Québec G7S 4K8 Canada

An on-line technique to measure the efficiency of decoating/delacquering processes is being developed by Alcan's Arvida R & D Centre. Decoating processes are used to remove moisture and coatings from shredded coated material such as Used Beverage Containers (UBC) before melting. Complete removal has been demonstrated to maximize metal recovery. Quantifying the weight of carbon and organic residue adhering to the shred surfaces is very difficult to measure directly, as the material can be highly folded. The technique developed indirectly measures the residue remaining by analysing the concentration of CO evolved in the decoater end zone exhaust gas. A commercial CEMS (Continuous Emission Monitoring System) incorporating an infrared type CO gas analyser was modified for on-line process exhaust gas analysis. Both pilot and plant trials had demonstrated that the CO concentration measured was inversely proportional to the efficiency of the organic removal achieved. As the quality of coated purchased scrap can be highly variable in moisture and organic content, continuous measurement should permit adjusting the feed rate and other decoater process parameters to the quality of decoating required.

2:50 PM

A Basic Study on Development of a Swell-Peeling Method in UBC Recycling System: K. Fujisawa[1]; T. Kogishi[2]; K. Oosumi[3]; T. Nakamura[4]; [1]Kobe Steel Ltd., Techn. Devel. Grp., Nishi-ju, Kobe, Japan; [2]Kobe Steel Limited, Techn. Test. Sect., Admn. Dept., Techn. Devel. Grp., Nishi-ku, Kobe, Japan; [3]Kobe Steel Ltd., Aluminum & Copper Co., Proc. and Appl. Mech. Res. Sect., Techn. Contr. Dept., Nishi-ku, Kobe, Japan; [4]Tohoku University, Inst. for Adv. Matls. Proc., Aoba-ku, Sendai, Japan

Recycling of used aluminum beverage cans (UBCs) is one of the important issues for aluminum manufacturer presently. The direct re-melting of UBCs shows two problems. One is a reduction in molten aluminum recovery and the other is a contamination of other metals such as Ti and Fe from paints. Both problems are caused by paints coated on the surfaces of aluminum cans. Removal technique of the paints, therefore, has been required. Although roasting and shot blast techniques have been developed, both were not successful in removing the paints effectively. A swell-peeling method has been applied to remove them using a methylene chloride solution with acids and it works very well. Small laboratory scale tests have been carried out to develop the commercial process and clarify the mechanism of the swell-peeling method in the present study. When the surface area of UBC is more than 10 cm^2, peeling time is independent of the surface area, about 60 seconds, because swelling phenomenon is controlled by the penetration of the liquid through the fine pits on the surface of the paint. This is good for a commercial process. Peeling takes place when the swelling force generated by methylene chloride exceeds the adhesion force between the film and the surface of aluminum, that is weakened by the coexisting acid, especially halogenated acetic acid.

3:15 PM Break

3:45 PM

Aluminum Recycling Via Near Room Temperature Electrolysis in Ionic Liquids: B. Wu[1]; R. G. Reddy[2]; R. D. Rogers[3]; [1]The University of Alabama, Ctr. for Green Manufact., P.O. Box 870202, Tuscaloosa, AL 35487 USA; [2]The University of Alabama, Dept. of Metall. and Matl. Eng., P.O. Box 87020, Tuscaloosa, AL 35487-0202 USA; [3]The University of Alabama, Center for Green Manufact., P.O. Box 870336, Tuscaloosa, AL 35487-0336 USA

Experimental studies on aluminum recycling via electrolysis in ionic liquids were carried out at the temperature of 105°C. Impure aluminum was dissolved at the anode and pure aluminum was deposited on a copper cathode. The products were characterized using an optical microscope, micro-image analyzer, X-ray diffraction, emission spectrometer, and atomic absorption analyzer. The electrorefining process with a current density of 310-730 A/m^2, and current efficiency of about 99% was obtained. Impurities such as Si, Cu, Zn, Fe, Mg, Cr, Ni, Mn and Pb were removed as anode residue. Impure aluminum was purified from 79.8wt% to 99.9wt%. At a cell voltage of 1 volt, the energy consumption of about 3 kWh/kg-Al was obtained. The process has advantages of low energy consumption and low pollutant emissions, compared with the current industrial refining process.

4:10 PM

Transportation of Molten Aluminum: R. D. Peterson[1]; G. G. Blagg[1]; [1]IMCO Recycling, Inc., 397 Black Hollow Rd., Rockwood, TN 37854 USA

Molten aluminum is routinely transported hundreds of miles to customers in large "over-the-road" crucibles. This is especially common for aluminum recycling organizations handling scrap and by-products. Receiving the aluminum in a molten form can save the customer time and money since in-house melting-costs and capital equipment can be avoided. Additionally, the alloy can be on specification and nearly ready to use for the casting operation. A number of transport crucible designs are currently in use. The specifics of each design are based on the needs of the customer, the equipment used at both the producer and the consumer, and over-the-road transportation constraints. Crucibles are designed to maximize carrying capacity, and refractory life while minimizing heat flow and dead weight. These conflicting demands place difficult design criteria on the design engineer. This paper will review the basic advantages and disadvantages associated with molten metal transport, give examples of the design restrictions and examine several types design of crucibles currently in use.

Secondary Copper, Nickel, Cobalt - I

Monday PM — Room: Brigade
October 23, 2000 — Location: Pittsburgh Hilton

Session Chairs: Larry M. Southwick, L.M. Southwick & Associates, Cincinnati, OH USA; Kunibert Hanusch, Huttenwerke Kayser, Lünen, Germany

2:00 PM

Recovery of Copper from Effluents by Supported Liquid Ion Exchange Membranes-From Laboratory Scale to an Integrated Pilot Plant: J. Vander Linden[1]; R. De Ketelaere[1]; M. Verhaege[2]; [1]KaHO Sint Lieven, CBOK, Gebroeders Desmetstraat 1, Ghent B-9000 Belgium; [2]Ghent University, Lab. of Non-ferr. Mets., Technologiepark 9, Ghent B-9052 Belgium

In this paper, results are presented concerning the search to implement Supported Liquid Membrane (SLM) technology for the recovery of copper from electroplating effluents. Acid copper electroplating rinse solutions or effluents resulting from the post-treatment of, for example, cyanide-containing copper electroplating baths all contain copper (2+) in the lower concentration levels. A thorough study of the influence of the individual parameters and of their combined impact on mass transfer in small scale laboratory SLM modules has been performed, enabling to set forward the appropriate operating conditions for a pilot plant installation. The pilot plant, containing two SLM modules of 18 m2 of surface area, has been tested extensively, including short and long term runs, with real process solutions. It was demonstrated that this installation is able to treat 40 l/h of acid copper sulphate rinse solutions containing 500 ppm of copper. The final copper concentration in the effluent can be reduced to a few ppm while copper metal is recovered by electrolysis of the concentrate. This technology is also applicable to the treatment of solutions with low copper content of origins other than plating shops, such as tailings from copper plants or mine waters.

2:25 PM

Copper and Zinc Recovery with Emulsion Membranes from Mine Waste Waters: D. N. Nilsen[1]; G. L. Hundley[1]; [1]U.S. Department of Energy, Albany Rsch. Ctr., Albany, OR 97321 USA

The U.S. Department of Energy investigated the use of liquid-emulsion membranes (LEM) for the selective removal and recovery of metals such as copper and zinc from mine waste waters. This investigation included field tests of a mobile, pilot plant-scale, continuous-flow LEM system. The system was tested at copper mines with solutions containing from 100 to 1,400 ppm Cu, and at a zinc mine with a solution containing 115 ppm Zn. Typical results from the copper tests were >90% copper recovery, and zinc extraction from waste water also was typically >90%. Although all of these waste waters contained high impurity levels, pure products were produced. On several of these field tests, integrated systems were tested that resulted in recovery of metal by-products, selective precipitation of iron, and polishing to reach discharge targets for essentially all of the contained metals. In addition, some results are included from laboratory-scale tests.

2:50 PM

Laboratory and Pilot Plant Processing of Spent Ni-Cd Batteries: M. Cavallini[1]; C. Lupi[1]; D. Pilone[1]; P. P. Milella[2]; A. Pescetelli[3]; G. Cannavale[4]; [1]University of Roma "La Sapienza", Dept. ICMMPM, Via Eudossiana 18, Roma 00184 Italy; [2]ANPA, Via Vitaliano Brancati, Roma 00144 Italy; [3]TEXECO Eng., Roma, Italy; [4]Mo. Smo.De. S.a.s., Crotone, Italy

Ni-Cd sealed and vented cells have been widely used in the last few years. The environmental hazard related to the heavy metals contained in Ni-Cd batteries is well known. Therefore, a number of scientific studies and commercial processes have been implemented in order to recycle them. Since spent batteries are a heterogeneous and complex material, any kind of recovery process needs some preliminary treatments. The proposed process described in this paper has been tested in laboratory and further developed in a pilot plant. It consists of a combination of mechanical and hydrometallurgical treatment steps, and is able to treat all type of Ni-Cd batteries. In particular, the mechanical treatments have to be done separately on vented and sealed cells, while the hydrometallurgical step is performed on a mixture of the two products obtained from mechanical steps. A fully automated dismantling line would allow the separate recovery of the plastic or metallic casing, terminals, KOH electrolyte, and electrodes to be further processed for Ni and Cd recovery. The electrodes coming from dismantling line and sealed batteries are submitted separately to an original crushing and elutriation treatment to separate metallic and active paste in the first case and metallic, plastic and active paste in the second case. The hydrometallurgical treatment is carried out on active paste bearing product to produce Ni, Cd, and Fe commercial salts through acidic leaching followed by a multi-step solvent extraction operation to obtain pure solutions.

3:15 PM Break

3:45 PM

Preparation of Nickel Sulfate from Spent Nickel-Cadmium Batteries: J.-S. Sohn[1]; K.-H. Park[1]; J.-S. Park[1]; H.-S. Jeon[1]; [1]Korea Institute of Geology, Min. and Matls. Process. Div., 30 Kajung-dong, Yusung-Ku, Taejon 305-350 Korea

This study has been carried out to develop a relatively simple hydrometallurgical process for recovering nickel as nickel sulfate from the spent nickel-cadmium battery residue in which cadmium was removed by vacuum distillation. This residue is composed of 36% nickel, 20% iron, and other metals such as cobalt. First, crushing and selective classification were performed to separate iron to produce a nickel-rich product (over 40% nickel). This product was dissolved in sulfuric acid to obtain a nickel sulfate solution. During the dissolution, nitric acid and air were added to the system to enhance the iron oxidation reaction rate. The free acid remaining in the dissolved solution was neutralized by adding nickel carbonate. Iron was precipitated as iron hydroxide and removed from the solution. The nickel sulfate solution was then fed to a vacuum evaporator to concentrate the solution by evaporation of water and crystallized at around 45ºC to obtain nickel sulfate hexahydrate. A recrystallization process could remove other impurities such as zinc and manganese.

4:10 PM

Melt Refining of Grinding Sludge Containing Cobalt and Nickel in an ESCR Furnace: V. M. Sokolov[1]; J. J. DuPlessis, Jr.[2]; [1]Physico-Technological Institute of Metals and Alloys of NASU, 34/1 Vernadsky Ave., Kiev-142, 03680 Ukraine; [2]Private Consultant, 1002 Brookshire Ct., Elizabethtown, KT 42701-2110 USA

The technology for recycling fine wastes, grinding sludges or swarf, and solids such as slag that contain a high content of metallic material needed improving. The objective was to produce a master alloy that met the tight requirements of the Western manufacturers and achieve improved yields of the valuable elements, nickel and cobalt, to over 90%. The alloys from the production of Alnico magnets were chosen for this work. A process is proposed that is able to recycle all kinds of Alnico wastes. This process is able to reduce all detrimental elements, which are contained in the wastes, to within acceptable levels. Molybdenum, if present, is an exception. Depending on the levels of contamination of undesirable elements different recycling strategies are proposed. The majority of the wastes can be recycled by melting and refining with a liquid slag layer using unique melting furnaces that are relatively unknown in Western nations. The proposed technologies allow the reclamation of over 95% of the cobalt and nickel from any kind of Alnico waste, and there are no limitations on the proportion of different kinds of wastes in the charge. The proposed processes and technologies could also be applied to the recycling of grindings, turnings, and other types of scrap from high temperature and other nickel and cobalt based alloys.

4:35 PM

Removal of Copper from Slag with the Aid of Reducing and Sulfiding Gas Mixtures: A. V. Tarasov[1]; S. D. Klushin[1]; [1]State Research Center of Russian Federation, State Research Institute of Nonferrous Metals, GINTSVETMET, 13 Acad. Korolev St., 129515 Moscow, Russia

The most common method for minimizing the copper content of residual slag in the process of autogenous smelting of sulfide raw materials is treatment of molten slag in an electric furnace, with optional addition of solid reducing agents, such as coke, and/or sulfiding agents such as pyrite. A drawback of this technique is the fact that the final slag produced still contains 0.5% or more Cu. We have tested a method for treating molten slag obtained as a result of autogenous smelting by a gaseous mixture of sulfur dioxide and methane at a ratio of $\sum C:SO_2$ = 0.75:1.0 in the presence of oxygen. Interaction reaction within the SO_2-O_2-CH_4 system proceeded at a high rate at 1373 to 1573K to form reducing and sulfiding agents: H_2S, S, COS, CO, CO_2, H_2, H_2O. The gas mixture requirement was about 100 to 150 Nm^3 per 1 tonne of slag. A decrease in the ferric iron concentration (Fe^{3+}) from 10-15% down to 2-3% resulted in lower solubility of copper in slag, and agitation of the melt with gas stream accelerated the separation of the sulfide phase and slag. Removal of copper from slag was performed in a pilot unit within the second Vanyukov furnace zone where slag arrived with a copper content of 0.8-1.3%. The temperature of molten slag was maintained within 1523 to 1573K. The copper content of the final slag was at a level of 0.12 to 0.14%. The matte sent to converting was a mixture of bottom matte from the smelting zone and the slag treatment zone. It had a copper content of about 50 to 55%. Process gases from both furnace zones were combined and sent to the acid plant for sulfur recovery. This process was offered for commercial use at two copper smelters in Russia and CIS.

Secondary Zinc

Monday PM — Room: Kings Terrace
October 23, 2000 — Location: Pittsburgh Hilton

Session Chairs: Larry L. Parkinson, Interamerican Zinc, Inc., Coldwater, MI USA; Stephen E. James, Big River Zinc Corporation, Sauget, IL USA

2:00 PM
The Need to Recycle Zinc: A Consideration of Public Perception, Politics and Competitiveness: D. R. Parker[1]; [1]Cominco Limited, 500-200 Burrard St., Vancouver, British Columbia V6C 3L7 Canada

This paper canvasses emerging trends in public policy and law, which may influence the zinc industry's interest in recycling. There are forces at work beyond direct economic benefits that will drive recycling of zinc, including: corporate determination to pursue sustainable practices and product stewardship; public perceptions and pressure; customer and investor demand; workforce recruitment; and protection and expansion of markets. In this paper, these "indirect" forces are examined with particular focus on the zinc industry. It is concluded that, in today's world with an emerging precautionary approach to policy and law making, public perception concerning the environmental implications of metal products, and the need to conserve resources for future generation, a strong industry response is required.

2:25 PM
Electrolytic Zinc Recovery in the EMEW® Cell: P. A. Treasure[1]; [1]Electrometals Technologies Limited, 28 Commercial Dr., Ashmore, Queensland 4214 Australia

The EMEW® cell has been developed to overcome a number of inherent limitations in conventional electrowinning technology, particularly the high cost and restricted process windows characteristic of conventional hardware. The technology has been widely demonstrated to achieve high performance for various metals under chemical conditions well outside the limits required for efficient operation of conventional cells. This process flexibility offers significant opportunities for cost savings in recovery of zinc from primary and secondary sources. The EMEW® technology is now available on a fully engineered basis, as a versatile commercial alternative to conventional electrowinning hardware. Application of the EMEW® cell for recovery of secondary zinc material offers significant advantages to the recycling industry. For example, a selective caustic leach can be used where there are high levels of iron or other contaminants in the target material. The reagent requirement is minimal as most of the caustic is regenerated in the cell and zinc dust that may be required for electrolyte purification is produced in the cell. A high purity zinc powder or cathode is produced in the cell. In the case of acidic zinc electrolytes, the cell is capable of operating over a much wider range of operating conditions than a conventional cell.

2:50 PM
Zinc Recycling Via the Imperial Smelting Technology–Latest Developments and Possibilities: B. Schwab[1]; W. -D. Schneider[1]; [1]M.I.M. Hüttenwerke Duisburg Gmbh, Richard-Seiffert Straβe 20, Mail Code 00010, Duisburg 47241 Germany

Like all metals, zinc can be recycled theoretically without end. To demonstrate environmentally friendly use of zinc, it is necessary to increase the recycling rate. In this regard, the Imperial Smelting Process developed in the forties and fifties in the United Kingdon has become more and more important. This unique process combined with a sinter plant, hot briquetting, and direct injection through the ISP furnace tuyeres offers ideal possibilities to recycle all kinds of zinc and lead bearing materials. Possible secondary materials include Electric Arc Furnace (EAF) dust, zinc-containing sludges and even zinc/carbon batteries. This high temperature process also destroys all organic materials, like dioxin, and can be seen as a sink for many harmful substances.

3:15 PM Break

3:45 PM
Dezincing of Zinc Coated Steel Scrap: Current Situation at Saint-Saulve Dezincing Plant of Compagnie Européenne De Dézingage (C.E.D.): D. Groult[1]; R. Maréchalle[1]; P. Klut[2]; B. T.H. Bonnema[3]; [1]Compagnie Européenne de Dézingage, Z.I. N°4-Rue du Président Lécuyer, F-59880 Saint-Saulve, France; [2]Triple M. Engineering & Contracting, Nijverheidsweg 27, 2031 CN Haarlem, The Netherlands; [3]Corus, P.O. Box-CA, IJHUIDEN, The Netherlands

In the past 5 years, Compagnie Européenne de Dézingage (CED) has developed a successful dezincing process and the St. Saulve pilot plant has evolved into a commercially successful production plant. Currently the plant meets all the required standards for scrap and zinc quality, output capacity, availability, and meets the prescribed environmental emissions standards. The initial process problems relating to zinc recovery, uncontrollable explosions and sodium hydroxide aerosol emissions have all been solved. Presently, the yearly production of dezinced scrap is around 50.000 tonnes/year; this capacity is enough to supply the local market. This capacity can be increased easily to 65.000 tonnes/year or more. The market for dezinced material is growing due to the increased consumption of galvanized material on one hand and on the other hand the higher demand for high quality scrap. The proven technology of CED is currently patented world wide, but CED is inviting licensees to implement the dezincing technology in other parts of the world.

4:10 PM
Recovery of Zinc from Zinc Ash and Flue Dust by Pyrometallurgical Processing: M. A. Barakat[1]; [1]Central Metallurgical R&D Institute, P.O. Box 87 Helwan, Cairo 11421 Egypt

Large amounts of zinc ash and flue dust containing more than 80% zinc are accumulated during galvanization processes at the surface of molten zinc bath and in the chimney respectively. Pyrometallurgical recovery of zinc from both of the ash and dust samples has been carried out. The ash was sieved with the help of an industrial sieve shaker provided with mesh sieve having a pore size 0.9 mm. The oversize fraction cut +0.9 mm) was melted at 550ºC under ambient conditions. The produced ingot (1) was analyzed whereas the coarse fraction of the produced slag (+0.9 mm) was treated as the coarse ash or added to it. The dust was enriched with suitable fluxing salt prior to heat treatment at 600ºC for 1 h. The produced ingot (2) was analyzed whereas the resulting slag was mixed with the fines of the ash and treated by hydrometallurgical processing to prepare valuable salts of zinc. Parameters affecting recovery processes such as time, temperature and flux percentage were studied. Results obtained revealed that the two prepared ingots (1&2) were successfully recovered with recovery efficiency amounts to ≥ 85%. The obtained samples meet the standard specifications with relatively low price. Also in the light of the strict environmental regulations of pollution control, reuse of these wastes materials will help in keeping the environment clean.

Automotive Materials Recycling

Tuesday AM Room: Kings Gardens
October 24, 2000 Location: Pittsburgh Hilton

Session Chairs: Donald L. Stewart, Aluminum Company of America, Alcoa Tech. Ctr., Alcoa Center, PA USA; Edward J. Daniels, Argonne National Laboratory, Argonne, IL USA

8:30 AM

Opportunities for Recycling Aluminum from Future Automobiles: M. Thomas[1]; [1]Alcan Aluminum Corporation, Detroit, MI USA

Aluminum has experienced significant growth in automotive applications over the last decade as a result of its properties and performance attributes. Looking to the future, the opportunities for continued growth in powertrain and suspension applications plus lightweighting of body structures offer the potential for considerable further growth. This represents a growing "energy bank" of aluminum that will become available for recycling at the end of these vehicles' lives. Today, around 90% of the aluminum is recovered and recycled from scrapped vehicles because of its high value relative to other materials. The future growth offers opportunity for new technology and practices, to maximize scrap quality and recycling application. This paper will review the demand for these new technologies and practices and will discuss industry activities being pursued in this area.

9:00 AM

Scrap Preparation for Aluminum Alloy Sorting: A. J. Gesing[1]; C. Stewart[1]; R. Wolanski[1]; R. Dalton[1]; [1]; L. Berry[1]; [1]Huron Valley Steel Corporation, 41000 Huron River Dr., Belleville, MI 48111 USA

As the quantity of aluminum recovered from shredder scrap continues to increase, together with increased content of aluminum in automobiles, so does the economic incentive to further upgrade shredder scrap. This upgrade will be done by sorting and recovering the aluminum by specific usable alloy compositions. The metal recycling industry infrastructure needed to deal with the increased aluminum scrap supply already exists. It is an inverted pyramid structure that in North America compromises: 3000 scrap collection yards, 200 shredders, a dozen sink-float plants and one heavy metal sorting operation. The technology for upgrading aluminum sorted from shredder scrap is already either in industrial use or in the final stages of pilot plant development. However, the current automotive aluminum recycling infrastructure will need to adjust to deal with higher volumes of the metal from aluminum-intensive vehicles that will be appearing in shredder scrap~20 years from now.

9:25 AM

Thermomechanical Treatments for the Separation of Cast and Wrought Aluminum: D. Maurice[1]; J. A. Hawk[1]; W. D. Riley[1]; [1]Albany Research Center, DOE, 1450 Queen Ave. SW, Albany, OR 97321 USA

The increased penetration of wrought aluminum into the automotive market is stimulating a need to separate wrought aluminum from cast aluminum because of: a) the additional value of scrap wrought alloys and b) the increase in the total amount of aluminum automotive scrap will outstrip the demands of secondary aluminum foundry industry. The availability of clean fractions of wrought and cast aluminum and incidentally, a clean cast magnesium fraction will allow increased recycling of aluminum used in the automotive industry. Hot crushing has been tested previously and proposed as a means to separate cast from wrought aluminum product. The underlying concept is that when a mixture of cast and wrought aluminum is thermally processed and then subjected to crushing action, differences in toughness between wrought and cast aluminum alloys will become more pronounced. Hence, it should be possible for conditions can be established such that the cast material fragments, while the wrought material, having lost much less of its toughness, merely deforms. The two types of product could then be separated by simple sizing methods. In this paper we report on the testing of this concept. We were unable to replicate the results which originally demonstrated proof of concept. Possible reasons for this are discussed, as well as the possibility that the original results may not be as desirable as the current results for subsequent sorting.

9:50 AM

Sensor Controlled Quality Control and Sorting of Scrap Aluminium Alloys: T. P.R. de Jong[1]; H. U.R. Kattentidt[1]; W. L. Dalmijn[1]; [1]Delft University of Technology, Dept. of Appl. Earth Scis., Mijnbouwstraat 120, 2628 RX Delft, The Netherlands

Sensor controlled sorting is a promising technique for the upgrading of scrap aluminium alloys. In a universal detection system of Delft University characteristic features are extracted from the material particles by means of cameras. Examples are size, texture, edge-structure, homogeneity, and colour pattern. Additional sensors are added for higher selectivity: electromagnetic detection, light transmission, spectral reflection and more. Signal processing theory learns that a classification of particles fundamentally improves as the number of independent features increases. At the laboratories of the Delft University a test bench is available for the development of advanced multi-sensor quality control and sorting systems. It is based on a software system for detection, segmentation and classification of particles, which was especially developed for this application. Work is now in progress for high-speed detection and sorting of non-ferrous alloys, including aluminium casting and wrought alloys. A recently developed actuator design enables positive sorting into more than 3 fractions of particles that are randomly orientated on a flat conveyor belt.

10:15 AM Break

10:45 AM

Materials Recovery from Shredder Residues: E. J. Daniels[1]; B. J. Jody[1]; J. Pomykala, Jr.[1]; [1]Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL 60561 USA

Each year, about five (5) million ton of shredder residues are landfilled in the United States. Similar quantities are landfilled in Europe and the Pacific Rim. Landfilling of these residues results in a cost to the existing recycling industry and also represents a loss of material resources that are otherwise recyclable. In this paper, we outline the resources recoverable from typical shredder residues and describe technology that we have developed to recover these resources.

11:10 AM

Recycling Plastics Scrap and ASR: The Simplicity of Automotive Recycling: I. Van Herpe[1]; [1]SALYP Elv Center, Rozendaalstraat 14-8900 leper, Belgium

Abstract text unavailable.

11:35 AM

A Novel Approach to the Mechanical Processing of ASR: N. Fraunholcz[1]; E. A. Schokker[1]; P. C. Rem[1]; W. L. Dalmijn[1]; [1]Delft University of Technology, Fac. of Appl. Earth Sci., Mijnbouwstraat 120, 2628 RX Delft, The Netherlands

Many processes developed for the mechanical processing of Automotive Shredder Residue (ASR) suffer from high processing costs. We offer a distinct concept for low-cost mechanical processing still allowing high value-added recycling of the recovered materials. The basic idea behind this approach is to produce saleable pre-concentrates at the lowest possible costs that can be further processed in existing separation facilities. Our process includes screening, size reduction and magnetic separation. Preliminary studies showed that fibers in ASR are magnetic due to adhering rust particles allowing separation into a fiber fraction and a non-magnetic rigid fraction by high-intensity magnetic separation. The fiber fraction is most suited for thermal processing. The rigid fraction mainly consists of plastics and rubbers with up to 10wt.-% of non-ferrous metals, some inert material and copper wires. This fraction is very well suited for mechanical processing by, e.g., sink-float separation in existing metal separation plants. The non-metal fraction can be processed further to recover the plastics and rubbers. The process proposed in this study is expected to be substantially cheaper than full thermal processing. In addition, as it mainly relies on existing separation facilities, it can be applied in the short term.

Aluminum Scrap Recycling - II Melting Technology

Tuesday AM — Room: Ballroom 1
October 24, 2000 — Location: Pittsburgh Hilton

Session Chairs: Ray D. Peterson, IMCO Recycling, Inc., Rockwood, TN USA; Jan H.L. van Linden, Recycling Technology Services, Edgewood, PA USA

9:00 AM
Explosions During Aluminum Scrap Melting in the Recycling Industry–Causes and Prevention: J. E. Jacoby[1]; [1]Consultant, 3398 North Hills Rd., Murrysville, PA 15668 USA

Scrap recycling has become an increasingly important source of metal units for the aluminum industry during the past 25 years. Aluminum scrap from the manufacture and recycling of cans, automobiles, buildings and other products has created an industry that melts these products and delivers the metal in molten or sow form to companies that make cast parts or fabricated products. This rapidly developing recycling industry has contributed a large number of severe (Force 3) molten aluminum explosions (25) with associated fatalities (19) to the Aluminum Association data accumulated during the past nineteen years. The explosions that occurred in recyclers plants represent 17% of the total explosions, 33% of the Force 3 explosions and 37% of the fatalities reported. These explosions can be prevented! This paper will identify causes of these explosions and procedures that can be used to prevent them.

9:25 AM
MeltSim: Melting Optimization for Aluminum Reverb Furnaces: R. M. Alchalabi[1]; C. S. Henkel[1]; F. L. Meng[1]; I. Chalabi[2]; [1]Chinook Sciences, LLC, 415 North Ave., Fanwood, NJ 07023 USA; [2]AMCS Corporation, 625 Central Ave., Westfield, NJ 07090 USA

For secondary aluminum producers to maintain a profitable melting operation, five technical factors have to be taken into account from the initial furnace building decision to the final operation and production. These factors are furnace design, furnace equipment selection, furnace control, furnace charge selection and inventory, and furnace operation. Any of these five factors, if not chosen or performed wisely, will likely result in sub-optimal melting operation. As a result the MeltSim melting optimization package has been developed by the collaborative effort of Chinook Sciences and AMCS Corporation to take into account these five factors. The package is a mixture of hardware, software, science and experience. The package incorporates years of reverb furnace operational observations, start-up installations, furnace-operator experience and furnace physicochemical mathematical model development. The optimization package enables aluminum producers to design new furnaces, select and place proper equipment, optimize existing furnace operations, and convert air-fuel installations to oxy-fuel. The package provides furnace operation monitoring and advisory signals, and furnace automatic optimal control to furnace operators, shift supervisors and plant managers, all customized, based on plant and melter need and ease of information management.

9:50 AM
A Vertical Floatation Melter for Decoating and Melting Scrap Aluminum: R. De Saro[1]; W. Bateman[1]; R. Jain[2]; [1]Energy Research Company, 364 Decker Ave., Staten Island, NY 10302 USA; [2]US Department of Energy, 1000 Independence Ave. SW, Washington, DC 20585 USA

A Vertical Floatation Melter (VFM) has been developed (sponsored by DOE) which simultaneously decoats and melts organic laden scrap in a single unit. Scrap aluminum is fed into the top of the VFM where it falls through a cone. Hot gases flow upwards through the cone, imposing a variable drag force on the scrap. Equilibrium is reached in which the scrap weight equals the drag force and the scrap becomes suspended. The gases strip off and vaporize the organics. Next, the scrap reaches a liquid state, taking on a more aerodynamic teardrop shape, allowing it to fall into a holding furnace. Heat transfer coefficients are 10 times higher than that of a conventional furnace, allowing rapid melting at a low gas temperature. Typical energy use is well under 2,324 joules/g (1,000 Btu/lbm) with a metal yield from 92 to 98%. This paper reports on the operation and data of a 453 kg/hr (1,000 pph) pilot-scale VFM.

10:15 AM Break

10:45 AM
An Innovative Stack Melter for Use in the Aluminum Casting Industry: E. Kear[1]; R. Rosenthal[2]; R. De Saro[3]; N. Schwartz[4]; [1]The New York State Energy Research and Development Authority, Corp. Plaza W., 286 Washington Ave. Ext., Albany, NY 12203-6399 USA; [2]Lexington Die Casting, Winchester Rd., Lakewood, NY 14750 USA; [3]Energy Research Company, 364 Decker Ave., Staten Island, NY 10302 USA; [4]O'Brien & Gere Manufacturing, 555 E. Genesee St., Fayetteville, NY 13066 USA

A Stack Melter has been installed and is currently operating at Lexington Die Casting. The Stack Melter consists of a 1 meter (3 foot) diameter refractory tube, 2 meters (7 feet) high. Specification ingots are continuously fed to the top of the melter and piled to nearly the top. A burner fires through the scrap which melts the lower portion and preheats the upper portion. As the lower portion is melted, it is drawn out and the upper preheated scrap falls to a lower level where it in turn melts. The molten metal is fed to one of two holding furnaces for eventual delivery to a casting machine. The Stack Melter's energy use is approximately 2900 joules/g (1,250 Btu/lbm), resulting in an overall energy savings of about 58%. This energy savings is brought about primarily because the flue gases preheat the scrap and the flue gas temperature is dropped to well under 528°C (1000°F).

11:10 AM
Thermal Dynamic Visualization Modeling and Optimization of Aluminum Sidewell Melting Furnace: C. T. Vild[1]; [1]Metaullics System Company L.P., 31935 Aurora Rd., Solon, OH 44139 USA

The restructuring of the secondary aluminum industry has some interesting technological consequences. The users of secondary metal, especially the smaller companies, are increasingly more interested in recycling their in-house scrap and augmenting that with purchased scrap. This creates a need for efficient remelting systems for smaller operations. The growing secondary producers, attempting to retain their customer base, are responding by introducing cost-cutting measures. In addition to the traditional steps, there is a growing interest in improving process efficiency and reducing melt losses through the application of technology, similar to that used so successfully by the integrated primary industry. In cooperation with industry leaders in the field, several melting systems have been developed and were introduced one year ago. Since then, a number of installations have been completed and are operational, the field data of which will be discussed.

11:35 AM

The Use of Electro-Magnetic Pumping for Melting and Circulation of Aluminium to Provide Production and Quality Benefits to the Aluminium Cast House: A. M. Peel[1]; [1]EMP Technologies Limited, Beeches House, Eastern Ave., Burton on Trent, Staffordshire DE13 OBB UK

Over the past years there has been an increasing demand by aluminium cast-house operations to obtain a greater return from their existing installed plant. This has included increasing existing furnace production capacity to match new and higher downstream production requirements, reducing melt losses and more efficient alloying. The paper discusses how Electromagnetic Pumping, which was developed for the combined purpose of: melting light gauge aluminium scrap with a reduced melt loss and; effective circulation of the aluminium melt, has established its self in recent years, as an effective means of satisfying many of these industry requirements, but how it has also provided many other additional operational benefits to the aluminium cast house. The paper will discuss operational performance of the system with a particular emphasis on its effect on the metal bath quality (alloying, chemical and temperature homogeneity), metal recovery and increased production due to the high circulation. The technology having now been adopted by a variety of industry leaders has a number of prominent references and the paper will discuss the operational benefits and experiences from some of these.

Precious Metals Recycling

Tuesday AM — Room: LeBateau
October 24, 2000 — Location: Pittsburgh Hilton

Session Chair: Robert L. Stephens, Cominco Research, Trail, British Columbia, Canada; V. Ramachandran, Scottsdale, AZ USA

9:00 AM

The Rebirth of UMPM Hoboken: D. Kennis[1]; [1]Union Miniere Precious Metals–Hoboken Business Unit, Ave Greinerstraat 14, Hoboken B-2660 Belgium

Union Miniere Precious Metal's (UMPM's) Hoboken Business Unit has a long tradition in complex Pb-Cu metallurgy, focussing on the recovery of precious metals from various types of secondary and recyclable materials. Although the old flow sheet, based on a traditional sinter plant, blast furnace, and lead refinery process was a very complete flow-sheet with the capability of dealing with almost every impurity, the weaknesses became clear: old and costly technology; too many unit operations; too much internal recycling; and dependency on concentrates for the sintering process. To maintain the competitiveness of the Hoboken Business Unit, the project "Smelter 2000" was born. This project represents a breakthrough in metallurgical processes and technology. A modern smelting technology was chosen together with the development of a new process. A lead-copper process combining lead slag and blister copper production, carried out in an ISASMELT vessel, was the key to simplifying the Hoboken flowsheet. ISASMELT smelting technology was chosen for its flexibility towards feed characteristics and process parameters. The new smelter was commissioned at the end of 1997. Although there were a lot of problems due to the high degree of technical innovations in the process, the new smelter came to design capacity within 1 year after start-up. During this period, however, UMPM had a very difficult time because of the extreme clear-cut nature of going from the old to the new flowsheet. After two and a half years of operation, the new flowsheet has proven to fit with the strategy of UMPM, focussing on treating secondary Pb-Cu materials and a broad range of recyclable feeds such as electronic scrap (E-scrap) and catalysts. Together with the new Precious Metals Plant, efficient logistics, recognised world class sampling practices and a customer-focussed commercial organisation, UMPM Hoboken can definitely be considered reborn.

9:25 AM

Metal Recycling at Kosaka Smelter: Y. Maeda[1]; H. Inoue[2]; S. Kawamura[2]; H. Ohike[2]; [1]Dowa Mining Co., Ltd., Marunouchi, Tokyo, Japan; [2]Kosaka Smelting and Refining Company Limited, Otarube 94, Kosaka, Akita 017-02 Japan

Kosaka smelter is the copper smelter in located in Akita Prefecture in the northern part of Japan. It has treated complex sulfide concentrates for a long time. Recently, in addition to metal production from ores, the company has been working on the recycling of metals by using this metallurgical technology. Metals recovered are primarily gold, silver, palladium, copper and lead from copper scraps, electronic board scraps, silver oxide batteries, spent lead acid batteries, semiconductor chips, cellular phones and automotive emissions catalyst. These electronic board scraps and cellular phones can be valuable raw materials. These electronic scraps are fed into the flash smelting furnace after size reduction in a shredder which was introduced in 1999. Due to the growing demand of personal computers and cellular phones, the amount of electronic board scraps available for recycling increased. At present, these secondary materials are good raw materials for Kosaka smelter since the smelter is already used to dealing with complex raw materials. The recycled metals account for up between 5 to 20 percent of the total production at Kosaka Smelter. In particular, over 90 percent of the palladium in the secondary materials can be recovered.

9:50 AM

Ausmelt Technology for Recycling of Computer Boards and Other High Value Materials: R. W. Matusewicz[1]; B. R. Baldock[1]; [1]Ausmelt Limited, (A. C. N. 005 884 355) 12 Kitchen Rd., Dandenong, Victoria 3175 Australia

The recycling of used computer boards is a key industry activity for the recovery of precious metals. The safe and effective separation of metallic from non-metallic materials and subsequent processing of these secondary materials to provide high recoveries of values and excellent environmental performance are critical process requirements. Ausmelt Technology has been used commercially in four plants for the recovery of precious metals and has also been used very successfully at pilot plant scale to process computer boards. This work and its application to commercial operations with particular reference to processing conditions and environmental performance are reviewed.

10:15 AM Break

10:45

Recycling Used Photographic Chemicals into High Quality Fertilizer: J. W. Whitney[1]; [1]Itronics, Inc., 6490 S. McCarran Blvd., Bldg. C Ste. 23, Reno, NV 89510 USA

Itronics Inc., through its wholly owned subsidiary Itronics Metallurgical, Inc. (IMI), has successfully developed technology that allows it to be fully integrated as a photochemical recycler. IMI is now using this technology to expand its regional operation, which collects used photographic chemicals, chemically removes 99.997% of the silver and uses the residual to make a line of high quality liquid multinutrient liquid fertilizer products. Elevated silver discharges from the Reno-Sparks sewage treatment facility, that were traced back to incoming waste photographic chemicals and which were seriously impacting the sensitive fishery, provided the impetus for this project. This paper is updated from a paper presented at the Twenty-Second International Precious Metals Conference Toronto, Ontario, Canada in June 1998. It presents an overview of the scope of the problem solved by the technology, some of the permitting and development issues, and some of the specific fertilization formulations that are now being marketed.

11:10 AM

Precious Metal Recovery with Electronically Conducting Polymers: M. Savic[1]; A. C. Cascalheira[1]; L. M. Abrantes[1]; [1]ICAT, Campo Grande, Lisboa 1700 Portugal

This paper reports our results on the application of a novel process for the spontaneous and sustained reduction and recovery of elemental silver and gold on an electroactive polymer surface. This work incorporates the metal recovery from photographic films (silver) and goldsmith residues (gold), by direct contact of metal containing solutions with polymer. The performance on such process of electrochemically and chemically prepared polyaniline (PANI) is evaluated. SEM coupled with EDX and XRD analyses confirmed the presence of metallic silver and gold deposited onto polymeric material.

11:35 AM

A New Technology for the Processing of Precious Metal Containing Secondary Raw Materials: O. Y. Goriaeva[1]; V. I. Skorohodov[1]; S. S. Naboychenko[1]; M. A. Verhaege[2]; [1]Ural's State Technical University, Mira St., 19, Ekaterinburg 620002 Russia; [2]Ghent University, Lab. of Non-ferr. Metall., Technologiepark 9, Zwijnaarde B-9052 Belgium

A new technology for the processing of secondary raw materials containing precious and Platinum Group Metals (PGMs) has been designed at the Laboratory of Heavy Metals at USTU. The technology is based on hydrometallurgical processing of the materials followed by sorption separation of the PGMs from the leach solution. Different versions of the technology can be realised depending on the type of processed material but the fundamentals are similar. Some parts of the technology can easily be integrated into existing flowsheets. The stage of sorption removal of platinum and palladium was tested on the site of the Joint Stock Company (JSC) “Uralelectromed” on pilot plant scale. A process was developed to obtain fine gold, silver, platinum and palladium. No waste is produced because all solutions are recycled. There are no gas emissions. Selective sorption of platinum and palladium from silver-containing solutions is possible even if the concentration ratio of silver to PGMs is one thousand to one. Sorption behaviour of the PGMs as a function of the bulk metal concentrations was studied. Recovery of 90-95% of platinum and 70-80% of palladium is possible.

Secondary Copper, Nickel, and Cobalt - II

Tuesday AM — Room: Brigade
October 24, 2000 — Location: Pittsburgh Hilton

Session Chairs: Larry M. Southwick, L.M. Southwick & Associates, Cincinnati, OH USA; Kunibert Hanusch, Huttenwerke Kayser, Lünen, Germany

9:00 AM

Lead Sulfate Scale in a Copper Smelter Acid Plant: J. M. Rapkoch[1]; [1]Kvaerner E & C, 12657 Alcosta Blvd., Ste. 200, San Ramon, CA 94583 USA

In late October 1996, an acid plant at a major U.S. copper smelter was faced with unexpected and rapidly increasing pressure drop across the gas cooling tower in the acid plant, indicating a build-up on the packing. This threatened to halt operations if not resolved. Earlier that month, a smaller vessel in the acid plant was found to be completely plugged with lead sulfate. It was feared that a similar fate awaited the gas cooling tower unless the scale build-up was stopped. Although lead sulfate is present in most copper smelter acid plants, this accumulation was unusually severe. An investigation was launched to find the source of the lead, determine how lead is transported to the gas cooling tower, recommend operating practices to prevent such severe scaling, and seek ways to recycle the lead value in the scale-covered polypropylene packing. Late in the investigation it was learned that the lead originated from an improperly executed recycling program.

9:25 AM

Recollections of Operations at a Secondary Copper Smelter and Refinery: The U.S. Metals Refining Company, Carteret, NJ: J. E. Hoffman[1]; [1]James E. Hoffman & Associates Company, Metall. Consult., P.O. Box 420545, Houston, TX 77242-0545 USA

The operation of the U.S. Metals Refining Company, USMR Co. is defined below by the description of a variety of unit processes and operations the author encountered during his tenure with the operation, 1955-1978. The operations discussed include: sampling and sweating of radiators, processing of Indian Coin, treatment of insulated wire, baghouse and converter dust treatment, blast furnace and converter operation, the electric arc furnace, antimony control, selenium and tellurium products, electrolyte liberation with soluble anodes, and the precious metals refinery. These operations, although peripheral to the primary copper production circuit, were critical to the company’s technological and economic base.

9:50 AM

Sampling of FSD-Type Cathodes Made from Recycled Copper: P. Barrios[1]; A. Alonso[1]; U. Meyer[1]; [1]Atlantic Copper S.A., Avda. Francisco Montenegro, s/n, Huelva 21001 Spain

The sampling of cathodes has changed with the introduction of the ISA-process in copper refineries. A Jernkontoret joint working group of refineries and rod plants from both primary and recycled copper plants has been investigating whether the actual sampling of cathodes is representative for this type of cathodes. As a first stage, samples were sent to the results of the next stages. All samples show the same tendency for nearly all elements. In some cases, there may exist differences in calibration and for some elements the detection limits are too high, especially when Optical Spectrometry is used. In the second stage, discs were compared with melted samples to answer the question whether the punching of discs is sufficient for the quality control of the cathode. The analyses of the discs represent fairly well the cathode quality. There are differences between cathodes from different crops. Three punches are sufficient to determine the cathode quality. Finally, samples from various lots of cathodes were compared with samples from the rod produced from these cathodes. The impurity content of the rod corresponds to the impurity content of the cathode.

10:15 AM Break

10:45 AM

Arsenic Sludge Recycle at Caraíba Metais S.A.: J. L.R. Bravo[1]; D. C. Foguel[1]; [1]Caraíba Metais S.A., Via do Cobre 3.700., A.I.O.-COPEC, Dias d’Ávila, Bahia, Brasil

For several years, Caraíba Metais S.A. (CMSA) had to stock the arsenic sludge generated from the electrolyte purification process of its tankhouse. The amount stocked reached approximately 3,500 tonnes, as the effects of its recycling during the smelting process and consequently in the sulfuric acid plant were unknown. Besides, it had as limiting factors the high content of arsenic in the copper concentrates supplied by foreign countries as well as the reduced capacity of the tankhouse’s purification plant. The choice for selling the mentioned residue, which generally contains more than 50% of Cu, was attractive, but the environmental policies and regulations had not allowed this option. Other alternatives, such as the production of bicupric arsenic by means of a solvent extraction process or arsenic trioxide, were considered but the economic feasibility was not attractive due to the absence of a domestic market and a poor international market. After a study of the arsenic partition in the metallurgical process, it was verified that the residue could be recycled without causing any operational problems or damage to the environment. To make this possible, the capacity of the purification plant was increased and the way of removing the arsenic sludge from the cells was modified from manual to mechanical, therefore avoiding the direct contact of the workers with this poisonous substance. Moreover, procedures for recycling in the smelter were established and tolerance limits were set for both the smelter and the sulfuric acid plant. The main amount of arsenic to be recycle is released with the smelting furnace off-gas, which is washed during the purification stage of the sulfuric acid plant. The acid water, rich in arsenic, is then treated in the waste plant and the arsenic, in its stabilized condition, is confined in an appropriate area.

11:10 AM

Electroslag Melting for Recycling Scrap of Valuable Metals and Alloys: V. V. Satya Prasad[1]; A. Sambasiva Rao[1]; [1]Defence Metallurgical Research Laboratory, Kanchanbagh, Hyderabad PIN: 500 058, India

Electroslag melting technologies have recently been developed for recycling light scrap of valuable metals and alloys such as superalloys and oxygen free high conductivity (OFHC) copper at Defence Metallurgical Research Laboratory (DMRL), Hyderabad. Conventionally, electroslag melting processes use consumable electrodes. Because of the difficulty in compaction of scrap into a consumable electrode of satisfactory quality, non-consumable electrodes such as graphite and water-cooled copper have been designed. Electroslag remelting using water-cooled non-consumable electrode was developed to melt scrap of a nickel base superalloy. Sound ingots with smooth surface finish and properties comparable to vacuum melted superalloys could be obtained from scrap using this process. A modified electroslag crucible melting process using graphite crucible and graphite electrode was developed for recycling of OFHC copper scrap. Copper ingots with oxygen less than 10 ppm and electrical conductivity ≈100% IACS could be produced. The same process was also utilized to produce copper-based alloys such as copper-chromium and copper-titanium starting from copper scrap.

11:35 AM

The Use of Secondary Copper for the Production of Rods and Tubes by Continuous Casting in an Electron-Beam Installation: S. V. Ladokhin[1]; V. B. Chernyavsky[1]; [1]Physico-Technological Institute of Metals and Alloys, Nat. Acad. of Sci. of Ukraine, 34/1 Vernadsky Ave., Kiev-142 03680 Ukraine

Equipment and continuous casting technology for the production of small diameter copper rods and tubes are described. Industrial copper wastes, such as scrap and shavings, were used as the charge. An electron-beam installation for rod and tube production includes a crucible with an electromagnetic stirring system and a pouring hole in its bottom, a bottomless mold, and a special cooling system, which includes an oil and water cooling devices. For the first time in the electron-beam technology, rods of 8 mm and 14 mm diameter and tubes of 14 mm external diameter and 7 mm internal diameter were produced through continuous casting by pulling them out of the vacuum chamber into the atmosphere with depressurizing the vacuum chamber. The production capacity of a single strand continuous casting machine was 200 mm/min for rod casting and 150 mm/min for tube casting.

Aluminum Dross Processing

Tuesday PM — Room: Ballroom 1
October 24, 2000 — Location: Pittsburgh Hilton

Session Chairs: Han Spoel, Dross Tec, Inc., Pittsburgh, PA USA; Annette S. Revet, Kalium Chemicals Limited, Regina, Saskatchewan, Canada

2:00 PM

Numerical Modelling of a Rotary Aluminum Recycling Furnace: S. B. Davies[1]; I. Masters[1]; D. T. Gethin[1]; [1]University of Wales Swansea, Mech. Eng. Dept., Singleton Park, Swansea, Wales SA2 8PP UK

The purpose of this model is to simulate and analyze the energy flows within a rotary aluminum recycling furnace, using the global properties of its main components, the gas, metal and refractory walls. The model will simulate a series of operations such as loading, heating and stirring which will constitute the processing of a batch. Each main component of the furnace is treated as a one-dimensional heat transfer medium, the thickness and area of each medium being calculated from the actual geometry of the furnace. The physical properties are taken as the weighted average of those for the various layers forming the medium. Incorporated into the model are elements describing the radiative exchange within the furnace, melting of the charge, and forced convection in the melt due to the rotation of the furnace. This approach has produced a model with a reasonable computing time that can be used to run a whole series of simulations for the prediction and comparison of the furnace performance under different operating conditions.

2:25 PM

Dross Reclamation at Aluminum Melting Furnace Sites: D. E. Groteke[1]; [1]Alcovery Technologies, L.L.C., 810 Botham Ave., St. Joseph, MI 49085 USA

This paper describes a new technology which allows aluminum drosses to be processed at the generating melting furnace to recover available metallic values. The systems, offered in both manual and automatic modes, are capable of processing quantities ranging from 15 to 200 lb. per cycle, and recovering up to 90% of the aluminum with a combination of agitation and chemical reactions. In the automatic mode, the separation of molten alloy and de-metallized dross is achieved in less than five minutes process time. The recovered alloy, of largely unchanged composition, may then be returned while at elevated temperature to the original melting furnace to achieve an additional saving of energy.

2:50 PM

DROSRITE Salt-Free Processing of Hot Aluminum Dross: M. G. Drouet[1]; R. L. LeRoy[1]; P. G. Tsantrizos[1]; [1]PyroGenesis, Inc., 1744 William St., Ste. 200, Montreal, Quebec H3J 1R4 Canada

DROSRITE is a unique process that makes possible economic in-plant recovery of metal from hot aluminum dross. It is environmentally friendly, requiring no salt and producing no CO_2 or NO_x gases. The salt-free residues of the process are suitable for production of calcium aluminate or for other value-added use. The process is highly energy efficient, extracting process heat from energy in the residue, and thus it does not require an external plasma-torch, electric-arc or fuel heat source. A DROSRITE pilot unit built by PyroGenesis has been tested with both black and white dross types. The unit was installed at two different aluminum plant locations, and tests were conducted for a total of six weeks "online" with hot metal holding furnaces where the dross was skimmed. Results of both of these industrial trials are presented, together with an economic analysis indicating cost savings in excess of $170 per ton of dross treated.

3:15 PM Break

3:45 PM

Improvements in Scrap Recycling and Dross Processing Using Oxygen: R. J. Hewertson[1]; D. J. Vandall[1]; [1]Air Products and Chemicals, Inc., Non Ferrous Comm. Tech., 7201 Hamilton Blvd., Allentown, PA 18195 USA

Since 1989 Air Products and Chemicals, Inc. has converted over 40 air fuel fired furnaces to oxy-fuel and air-oxy-fuel. Advances in burner design, flow control technology and operating experience have lead to improved performance with quicker melt times and lower costs. Metal recoveries are improved by faster melting and better furnace atmosphere control, allowing lower grade materials to be processed economically. The presentation will discuss the improvements made in recent years and review data from state of the art installations.

4:10 PM Panel Discussion - Dross Treatment Technology

EAF Dust Processing - I

Tuesday PM — Room: Kings Gardens
October 24, 2000 — Location: Pittsburgh Hilton

Session Chairs: James C. Daley, Daley & Associates, Phoenix, AZ USA; A. D. Zunkel, A. D. Zunkel Consultants Inc., Vancouver, WA, USA

2:00 PM

Recovering Zinc and Lead from Electric Arc Furnace Dust: A Technology Status Report: A. D. Zunkel[1]; [1]A. D. Zunkel Consultants, Inc., 8020 N.E. 71st Loop, Vancouver, WA 98662 USA

Increasing amounts of electric arc furnace dust (EAFD) are being generated worldwide as more steel is produced from electric furnace melting of galvanized steel scrap. In the USA alone, 700,000-800,000 MTPY are generated containing 140,000-160,000 MTPY zinc and 7,000-8,000 MTPY lead. In addition, the material is often classified as a hazardous waste-K061 in the USA. Many technologies and processes are being used and developed worldwide to manage this material to recover contained zinc, lead, and iron values and render it nonhazardous. These processes are pyrometallurgical, hydrometallurgical, and hybrid in nature. Some produce zinc oxide, some zinc metal, some lead metal, and some lead cement. Some are successful, some have failed, many are dormant or abandoned, and others continue to be developed and emerge. This paper updates the current status of 20-30 processes in various stages of commercial application and development used worldwide to manage EAFD and recover its nonferrous, particularly zinc and lead, and ferrous values.

2:25 PM

The Current Status of Electric Arc Furnace Dust Recycling in North America: M. Liebman[1]; [1]AIM Market Research, 3380 Babcock Blvd., Pittsburgh, PA 15237 USA

We present the results of a telephone survey of electric arc furnace (EAF) steel producers. This report characterizes the current status of EAF dust generation, treatment and disposal. It indicates the quantity generated, zinc content, other relevant constituents, and plans and trends that will impact on the quantity and characteristics of the dust generated. The survey covers EAF based steel producers in the United States and Canada. It identifies the processors currently employed, opinions about the use of these processors and services, as well as new technologies being considered.

2:50 PM

Reclamation of Valuable Metals from Hazardous Waste: E. C. Cernak[1]; A. J. Maselli[1]; [1]Hartford Steel Technologies, One State St., P.O. Box 5024, Hartford, CT 06102-5024 USA

Hartford Steel Technologies (HST) has a pyrometallurgical and hydrometallurgical process capable of reclaiming valuable metals from a hazardous waste stream such as EAF Dust. The HST Process effectively addresses the growing environmental concerns surrounding the increasing production of EAF Dust without producing any hazardous waste material as byproducts. Currently EAF Dust production levels are exceeding the 1,000,000 metric tons per year mark. The HST Process is designed to separate iron, zinc, lead, cadmium, copper, and silver metals using a two-phased process. The Pyrometallurgical side of the Process utilizes a Rotary Hearth Furnace to separate the iron metal from the remaining metals. These remaining metals are further separated, using a Hydrometallurgical Process, in a series of digestion tanks. The individual metals are then collected in saleable form.

3:15 PM Break

3:45 PM

Fundamental Study of Fe-Zn Intermetallic Compounds for Zinc Evaporation from Galvanized Steel Sheet: K. Mita[1]; T. Ikeda[1]; M. Maeda[1]; [1]University of Tokyo, IIS, 7-22-1 Roppongi, Minato-ku, Tokyo, Japan

Galvanized steel sheet is the major product for the automobile industry. Therefore, automotive recycling results zinc-containing scrap that should be remelted in EAF's. Naturally, the EAF-dust is very important source of zinc for zinc recycling process. The thermodynamic properties of the Fe-Zn intermetallic compounds formed on the surface of galvanized steel sheet should be clarified to make clear the evaporation mechanism of zinc, however, there are few reports on these compounds because of difficulties in their synthesis. There are various intermetallic compounds in the Zn-Fe system. We synthesized them at about 673K. A specimen was examined chemically and X-ray diffraction was applied to ensure the formation of intermetallic compounds. Material containing two phases was placed in a Knudsen type effusion cell and the mass spectrum studied to evaluate the vapor pressure of zinc. The thermodynamic property of intermetallics was then evaluated through measured intensity.

4:10 PM

Characterisation and Removal of Halogens in the EAF Dust and Zinc Oxide Fume Obtained from Thermal Treatment of EAF Dust: G. Ye[1]; [1]MEFOS, P.O. Box 812, Luleå SE-971 25 Sweden

One of the most essential problems associated with the treatment of EAF dust is its high content of halogens. For the most thermal processes for Zn-recovery such as the plasma processes with a Zn-condenser the halides in the gas stream will form a dross phase which will result in a low Zn-yield. For those with ZnO as main product such as Waelz oxides the high halogen content in the product implies a great degradation of the product quality and the product can only be sold for a low price. Further processing of ZnO with high halogen content either by pyrometallurgical or hydrometallurgical processes will also results in process problems. This paper will review the pre- and post treatment alternatives for halogen removal based on the comprehensive characterization work that have been carried out at MEFOS and the preliminary experimental results. The experimental results show that chlorine- and fluorine-content could be reduced to 450 ppm and 50 ppm respectively by selective sulfation and to about 200 ppm by soda leaching. Selective sulfation of zinc oxide in the EAF dust will also be discussed.

Electronics/Plating By-Products Recycling

Tuesday PM — Room: LeBateau
October 24, 2000 — Location: Pittsburgh Hilton

Session Chairs: Paul B. Queneau, P.B. Queneau & Associates, Golden, CO USA; Lee Wilmot, HADCO Corporation, Salem, New Hampshire USA

2:00 PM

Commercial Practices of U.S. Specialty Recycling Operations: D. J. Cassidy[1]; [1]Agmet Metals, Inc., 7800 Medusa St., Oakwood Village, OH 44146 USA

This document discusses commercial strategies and applications of specialty processing plants for the recycling of nickel, copper, zinc and cobalt bearing by-products. For this discussion, I will focus on materials originating from the metal plating, electronic circuit board and chemical industries. The review of select processes and the required service, sourcing, material handling, processing and marketing strategies necessary for a successful recycling program are highlighted. Materials discussed in this summary include filtercakes, filters, dusts, spent catalysts, spent solutions and solids. Both pyrometallurgical and hyrometallurgical applications to these materials are addressed. A comparison of targeted finished markets, including smelter feeds and value added products are also reviewed.

2:25 PM

Development and Manufacture of an Innovative Mineral Feed Ingredient Produced from Recycled Copper: F. A. Steward[1]; [1]Micronutrients, Div. of Heritage Technologies, LLC, 1550 Research Way, Indianapolis, IN 46231 USA

Copper is one of the trace minerals essential to life. It is added, usually in the form of copper sulfate, to virtually all formulated feedstuffs and to dietary supplements fed to animals on forage. Over the past five years, an improved inorganic copper source trademarked Micronutrients TBCC™, has been developed, tested and commercially introduced. TBCC™ is a crystalline form of basic copper chloride. Synthesis is accomplished in a continuous neutralization/crystallization process. In current commercial production, the primary sources of copper currently used as feedstocks are the etching solutions used to manufacture electronic printed wiring boards. These solutions have traditionally been managed as hazardous wastes, but their use to manufacture TBCC™ exempts them from regulation as wastes under the “Use/Reuse” provisions of RCRA. Research conducted over five years at multiple universities has shown that animals are healthier when fed this source of copper and that vitamin losses in feed are reduced by its use.

2:50 PM

Electrochemical Treatment of Spent Electroless Nickel Solution: R. Macko[1]; T. Mason[2]; [1]US Filter/IWS, 28 Cook St., Billerica, MA 01821 USA; [2]North American EN, Inc., 450 Crossen Ave., Elk Grove Village, IL 60007 USA

Electroless nickel (EN) coatings are widely used in the manufacture of automotive parts, providing uniform coating, corrosion protection, wear resistance and lubrication. In contrast to EN plating benefits, the disposal and treatment of waste solutions can cause many difficulties. The use of electrochemical treatment technology greatly improves the operation of the main wastewater treatment process and reduces operation costs. A new, state-of-the-art job shop in the Chicago area, which provides EN plating for the automotive industry, has installed a large separated electrolytic cell for the treatment of spent EN solution (from dumps and wastewater). The waste/wastewater is handled by the separated electrolytic cell, batch treatment system, filter press and neutralization station. The implementation of modern electrolytic technology and auxiliary equipment provides an effective waste treatment process that meets environmental compliance criteria.

3:15 PM Break

3:45 PM

Recycling of Tin/Lead Bearing By-Products from the Electronics Industry: A. N. Aposhian[1]; [1]Alpha-Fry Technologies, 4100 6th Ave., Altoona, PA 16602 USA

The electronics industry generates tin/lead bearing by-products that can be recycled for their metal-value. This paper will cover the processes used to recycle these tin/lead bearing by-products from the plating, circuit-board fabrication and assembly industries. Though these processes are well known to the companies who do the recycling, few outside the industry including the generators of the by-products, understand the processes or needs of the industry. This paper will give a broad overview of these processes, and describe the services provided by this industry. The paper will also touch upon the future of the recycling industry, including the legislative and environmental push for the elimination of lead from electronics.

4:10 PM

Success Stories of an Innovative Water Recycling Method Using Carbon Adsorption to Recover Heavy Metals from Industrial Wastewater: T. Lewis[1]; [1]Lewis Environmental Services, Inc., 5500 Butler St., Etna, PA 15223 USA

The metal finishing and electronic industries are searching for ways to recycle materials and reduce costs. The areas of heavy metal waste and water recycling has gained new interests with the potential of impacting the operation’s bottom line. Lewis Environmental Services, Inc. has completed numerous heavy metal recovery and effluent recycling projects with its ENVIRO-CLEAN PROCESS for government and private sector clients. This patented process utilizes a proprietary chemically treated granular activated carbon with enhanced heavy metal adsorption capabilities combined with electrolytic metal recovery to produce a saleable metallic product. The process generates no sludge or hazardous waste and the effluent meets EPA limits. This paper covers several heavy metal removal projects, two full-scale commercial installations, and one treatability case study.

4:35 PM

Lead Removal by Ion Exchange: P. Meyers[1]; L. Gottlieb, F. DeSilva[1]; [1]ResinTech, Inc., 1980 Old Cuthbert Rd., Cherry Hill, NJ 08034-1409 USA

A number of tests looking at lead removal using ion exchange resins of various types from various aqueous streams have been undertaken. The tests focussed on strong acid cation (SAC) and weak acid cation (WAC) resins. It was found that the mechanism of lead removal is partly by lead filtration rather than solely by ion exchange in most applications. This isnot surprising since lead carbonate is essentially insoluble and almost all water supplies contain at least some alkalinity. Regeneration of lead from exhausted resins containing significant amounts of lead may not be practical in some cases because of the large chemical and waste volumes involved. Since lead, along with many other very insoluble metals, is often present as a suspended solid rather than in ionic form, ion exchange is not always the best technology for bulk lead removal.

Secondary Lead - I

Tuesday PM — Room: Brigade
October 24, 2000 — Location: Pittsburgh Hilton

Session Chairs: Andreas Siegmund, RSR Technologies, Inc., Dallas, TX USA; Richard Leiby, East Penn Manufacturing Company, Lyon Station, PA USA

2:00 PM

Operations at the Doe Run Company's Buick Resource Recycling Division: J. A. Moenster[1]; M. J. Sankovitch[1]; [1]The Doe Run Company, HC 1, P.O. Box 1395, Boss, MO 65440 USA

Doe Run's Buick Smelter was converted from a primary lead smelter to a secondary lead smelter in 1991. The recycling facility was designed to produce 60,000 tons of refined lead per year from 110,000 tons of spent starting-lighting-ignition (SLI) batteries and 10,000 tons of lead contained in drosses and scrap. Since commissioning, Buick's refined lead output has steadily increased to exceed 120,000 tons for 1999. The production gains have been the result of continuous process improvements, empowerment of the workforce, and development of additional scrap lead streams. The production gains were accomplished while setting industry standards for employee safety, reducing plant environmental emissions and employee blood leads, achieving ISO 9002 certification, and expanding product lines to meet customer requirements. This paper highlights Buick's major accomplishments through the 1990's.

2:25 PM

Operation of a High-Output, One-Pass Smelting System for Recycling Lead-Acid Batteries: M. Vondersaar[1]; B. Bulnes[1]; [1]RSR Quemetco, Inc., 720 S. 7th Ave., City of Industry, CA 91746 USA

Quemecto, Inc., as a subsidiary of RSR Corporation, operates one of RSR's three secondary lead smelters in the City of Industry, California, next to a residential area within Los Angeles County. The Reverberatory furnace serves as the main reactor for melting lead grid and paste recovered by the battery crushing system. Feed material is introduced via screw conveyor after drying in an upstream rotary kiln. Slag produced by the Reverb flows directly to an electric arc furnace. Products from this one-pass furnace system consist of soft lead bullion from the reverb, hard lead bullion from the arc furnace, and a non-hazardous slag from the arc furnace. Furnace bullion is processed into finished product in a six-kettle refinery. An overview of plant operations is presented. Where applicable, references will be made to changes that have taken place during the last decade.

2:50 PM

Technology for Processing of Lead-Acid Batteries at Mülden-Hütten Recycling Und Umwelttechnik GmBH: H. -P. Behrendt[1]; [1]Mülden-Hütten Recycling und Umwelttechnik GmbH, Hüttenstraβae, D09599 Freiberg, Germany

Muldenhütten Recycling und Umwelttechnik GmbH is a lead smelter with a very long tradition. The first reference to the existence of smelters on this site is given by a document of inheritance dated 1318. Originally run as a primary lead smelter, which was supplied with ores from the Freiberg mining district and from overseas, it was required to change it over to secondary raw materials due the abandonment of mining in the Freiberg area in 1968. Today, Muldenhütten Recycling und Umwelttechnik GmbH has two production lines; lead production from secondary lead and waste incineration, which are closely connected and gain advantage from each other. Installations, improved technologies, and the highly skilled personnel have contributed to satisfy all demands for a production concerning quality and environment.

3:15 PM Break

3:45 PM

Recovery of Polypropylene from Lead-Acid Battery Scrap: G. Martin[1]; A. Siegmund[2]; [1]BSB Recycling Gmbh, Braubach, Germany; [2]RSR Technologies, Inc., 2777 Stemmons Freeway, Ste. 1800, Dallas, TX 75207 USA

The recycling of metal containing scrap is a common practice in the industry and has a long tradition. In recent years, this philosophy has been transferred to organic materials, in particular to thermoplastic polymers. BSB Recycling GmbH, a company with a long experience in the treatment and recovery of lead from battery scrap, had recognized this exploitation at an early stage and challenged it by a consequent continuation of the idea to recycle materials other than metals without degradation and maintaining the quality. These efforts resulted in an economic and environmentally acceptable solution producing high quality polypropylene compounds at BSB beside lead and lead alloys from battery scrap. The raw material for the production of polypropylene compounds is shredded plastics from the separated casings of spent lead-acid batteries. The production of polypropylene with specific physical and mechanical properties is carried out by the accurate dosing of organic as well as inorganic additives. The result of the procedure is a novel product group "Seculene PP", a registered trademark of BSB Recycling GmbH.

4:10 PM

Sulfur Injection to Remove Copper from Recycled Lead: G. Plascencia-Barrera[1]; A. Romero-Serrano[1]; R. D. Morales[1]; S. González-López[1]; F. Chavez-Alcala[1]; D. Silva-Galvan[2]; [1]IPN-ESIQIE, Dept. of Metall., Apdo. Postal 75-874, Mexico D.F., CP 07300; [2]ENERTEC, Av. Eugenio Garza Sada Sur 3431, Mty, N. L., Mexico

This work is focussed on lead decopperising by two techniques: conventional top addition of sulfur and injection of sulfur powder. It is found that the first method proceeds under equilibrium conditions and the second one depends on kinetic considerations. Experiments were carried out using 15 kg lead baths at two temperatures, 340°C and 380°C. The carrying gas used for the injection trials was nitrogen at flow rates of 6.3 and 18.6 L min-1. The results show that decopperising process is more efficient at temperatures close to the melting point of lead for the sulfur top addition process, whereas high temperatures produce better copper removal for the injection of sulfur powder. Besides, the sulfur injection with the higher nitrogen flow rate (18.6 L min-1) produced higher decopperising rates. Thermodynamic and kinetic models are used to simulate this lead refining process.

4:35 PM

Waste-Less Technology for Processing of Subgrade Lead Concentrates and Flotation Middlings Containing Precious Metals: A. V. Tarasov[1]; A. D. Besser[1]; [1]State Research Center of Russian Federation, State Research Institute of Nonferrous Metals, Gintsvetmet, 13 Acad. Korolyov St., Moscow 129515 Russia

A processing flowsheet has been developed for treating substandard lead-containing polymetallic bulk concentrates and intermediate flotation products containing precious metals, which comprises oxidizing roasting in a calcination kiln and electrothermic smelting generating low volumes of off-gas. The proposed flowsheet also incorporates a dust collection system and sulfur dioxide recovery from off-gas. It is proposed to implement this process by using a reaction smelting technique. For this purpose, the charge to be fed to the smelting furnace after its calcination in a drum-type rotary kiln must have a ratio of sulfide sulfur to sulfate sulfur of at least 1:2. Electric smelting makes it possible to produce lead bullion that also collects the precious metals contained in the feed, as well as copper-lead matte and slag containing zinc. The recovery of lead into lead bullion and into matte is approximately 83% and 14%, respectively (thus the overall recovery is 97%); the total recovery of gold and silver into lead bullion and matte is 98%; that of copper into matte is 89%; the recovery of zinc into slag is 96%; and that of sulfur into sulfuric acid or gypsum is 90%. After the recovery of zinc from slag, the latter can be utilized in the construction industry.

Aluminum Scrap Recycling - III Quality Considerations in Recycling

Wednesday AM   Room: Ballroom 1
October 25, 2000   Location: Pittsburgh Hilton

Session Chairs: Ray Peterson, IMCO Recycling Inc., Rockwood, TN USA; Jan H.L. van Linden, Recycling Technology Services, Edgewood, PA USA

9:00 AM

The Importance of Metal Quality in Molten Secondary Aluminum: C. E. Eckert[1]; B. Cochran[2]; [1]Apogee Technology, Inc., 1600 Hulton Rd., P.O. Box 101, Verona, PA 15147-2314 USA; [2]Wabash Alloys, LLC, 4525 w. Old 24, P.O. Box 466, Wabash, IN 46992-0466 USA

The commercial incentives for using molten aluminum in casting operations are numerous and substantial. Although these incentives apply broadly to both shape castings (foundry) operations and wrought alloy production, the merit of a particular motive is indeed downstream processing sensitive. Melting cost reduction is a universal incentive that impacts on essentially all aluminum products. At a natural gas burner cost of $4.50 per therm, for example, the reverberatory furnace energy cost is at least $0.01 per pound of aluminum melted, exclusive of melt loss, fixed costs, and other expenses. The Aluminum Statistical Review cited 3.188 million metric tons of secondary aluminum that was recovered by the industry in 1995. This represents a re-melt energy cost of over $70 million. Other incentives to use molten secondary aluminum include throughput enhancement, metal chemistry assurances, environmental considerations, and the avoidance of an in-house scrap processing operation. A traditional disincentive to use molten secondary aluminum is metal quality. If a particular secondary processing operation was successful in achieving and preserving an acceptable metal quality level prior to shipment, the subsequent metal transfer and ladle delivery events would frequently obviate these efforts. For example, a metal superheat on the order of several hundred degrees is required for an unheated transfer ladle to travel 3 to 4 hours to a customer location. The rate of the g-alumina formation reaction approximately doubles for every 120°F increase in temperature, therefore, the effect of excess superheat on melt loss and metal quality is considerable. Linear oxidation reactions, such as magnesia formation in magnesium containing alloys, are influenced to an even greater extent by temperature.

9:25 AM

Recycling–A Fan of the Can: W. B. Steverson[1]; [1]Alcoa, Inc., 900 S. Gay St., Knoxville, TN 37902 USA

The author will review the current Aluminum Used Beverage Can (UBC) recycling environment and recent changes having major impacts on the industry. The importance of can recycling and the associated significant effects contaminants can have on plant safety, productivity, and overall efficient melting operations will be discussed.

9:50 AM

Development of New Filter for Removal of Non-Metallic Inclusions From the Molten Aluminum: K. Oosumi[1]; Y. Nagakura[1]; R. Masuda[1]; Y. Watanabe[2]; T. Ohzono[3]; [1]Kobe Steel, Ltd., Techn. Dept., Aluminum & Copper Company, 5-9-12, Kita-Shinagawa, Shinagawa-ku, Tokyo, 141-8688, Japan; [2]Nippon Light Metal Co., Ltd., 2-2-20, Higashi-Shinagawa, Shinagawa-ku, Tokyo, 140-8628, Japan; [3]The Japan Research and Development Center for Metals, 1-26-5 Toranomon, Minato-ku, 105-0001, Japan

In order to promote recycling of aluminum scrap, it is required to remove inclusions that have a remarkable influence upon the product quality. An internal filtration technology using a new filter, which is made by coating an adhesive on the surface of the conventional filter, has been developed as a new removing technology for inclusions. The technology has made it possible to remove inclusions as small as 10-20mm in the molten metal, which have been impossible to be removed by the surface filtration technology using conventional filter. An inclusion removal rate of up to 90% has been attained. The technology will contribute not only to recycling of aluminum products but also to the improvement in the quality of current products.

10:15 AM Break

10:45 AM

Refining Aluminium Scrap by Means of Fractional Crystallisation: Basic Experimental Investigations: W. H. Sillekens[1]; J.A. F.M. Schade Van Westrum[1]; O. S.L. Bruinsma[2]; B. Mehmetaj[3]; M. Nienoord[4]; [1]TNO Institute of Industrial Technology, Div. of Prod Tech., P.O. Box 6235, 5600 HE Eindhoven, Netherlands; [2]Delft University of Technology, Lab. for Proc. Equip., Leeghwaterstraat 44, 2628 CA Delft, The Netherlands; [3]Delft University of Technology, Lab. for Matls. Sci., Rotterdamseweg 137, 2628 AL Delft, Netherlands; [4]TNO Environment, Dept. of Chem. Eng., P.O. Box 342, 7300 AH Apeldoorn, The Netherlands

Recycling of aluminium is an effective way of enhancing the efficient use of energy and limiting the burden on the environment. Where cascade recycling is an established way of using reclaimed aluminium, closing the recycling chain is currently hampered by the unavailability of suitable techniques for refining contaminated scrap on an industrial scale. To overcome this problem, purification based on fractional crystallisation appears to be a promising option. This implies that the material is to be processed in the semi-solid state; that is, at a temperature where a solid and a liquid phase co-exist. In the current paper, it is shown that zone melting can serve as an indicative test for assessing the refining potential of fractional crystallisation processes, since they are both based on the same thermodynamic principle. Next, the results of zone-melting experiments are presented for some representative aluminium model alloys. The BPS-model (developed by *Burton, Prim and Slichter*) is used to interpret these results, from which it is concluded that the model needs extension to obtain a predictive tool for fractional crystallisation processes.

11:10 AM

Refining of a 5XXX Series Aluminum Alloy Scrap by Alcoa Fractional Crystallization Process: A. I. Kahveci[1]; A. Unal[2]; [1]Alcoa Primary Metals, Spec. Met. Div., Alcoa Tech. Ctr., Alcoa Center, PA 15069 USA; [2]Alcoa Mill Products, Davenport Works, Alcoa Tech. Ctr., Alcoa Center, PA 15069 USA

Alcoa developed a fractional crystallization process some 30 years ago as a method to purify aluminum. Depending on the purity of feed metal, it has been commercially used to make 3N7-6N purity aluminum. As an extension of this technology, Alcoa has experimented with purifying various aluminum alloy scrap for the purpose of recycling. Purified aluminum alloy scrap can be reused for making the same alloy. This presentation will discuss Alcoa fractional crystallization technology and its application to alloy scrap processing. Process capabilities and the partitioning of eutectic and peritectic impurities during fractional crystallization will be discussed for the alloy systems investigated.

11:35 AM

A New Proposal of Continuous Agitation Vacuum Distillation Process (CAVP) to Remove Zn from Aluminum Scrap Melt: M. Ohtaki[1]; T. Arakawa[2]; F. Murata[3]; [1]The Furukawa Electric Company, Ltd., Metal

Res. Ctr., 500 Kiyotaki-machi, Nikko-City, Tochigi, 321-1493 Japan; [2]Sky Aluminium Co., Ltd., 1351 Uwanodai, Fukaya-City, Saitama, 366-8511, Japan; [3]The Japan Research and Development Center for Metals, 1-26-5 Toranomon, Minato-ku, Tokyo 105-0001, Japan

Refining of Zn from aluminum scrap melt by some vacuum distillation processes was studied to promote aluminum scrap recycling. Effects of distillation conditions, such as melt temperature, vacuum pressure and holding time, on Zn distillation behavior were investigated theoretically and experimentally by 0.3kg/ch scale vacuum resistance furnace. Three methods to increase the surface-area/volume ratio of liquid metal, such as gas atomizing, mechanical atomizing and mechanical stirring, were tested to increase the Zn distillation rate in 5kg/ch scale vacuum resistance-furnace. It was easy to lower the remaining Zn content to less than 0.lwt% within one minute by mechanical stirring method. A water-model simulation experiment indicated that a significant agitation of the melt by stirring would be effective to increase the distillation rate. Continuous agitation vacuum distillation process (CAVP) has been designed and the pilot plant is now in construction.

EAF Dust Processing - II

Wednesday AM — Room: Kings Gardens
October 25, 2000 — Location: Pittsburgh Hilton

Session Chairs: James C. Daley, Daley & Associates, Phoenix, AZ USA; V. R. Daiga, Maumee Research & Engineering Inc., Northwood, OH, USA

9:00 AM
Upgrading of EAF Dust by Injection into Iron and Steel Melts: D. Colbert[1]; G. A. Irons[1]; [1]Dofasco, Inc., P.O. Box 2460, Hamilton, Ontario L8N 3J5 Canada; [2]McMaster University, Dept. of Matls. Sci. and Eng., Hamilton, Ontario L8S 4L7 Canada

Several electric arc furnace (EAF) shops have increased the zinc and lead grades of EAF dust by reinjecting it into their furnaces; however, the kinetics of this operation are poorly understood. To understand the kinetics, EAF dust was injected into 70 kg heats of iron or steel in an induction furnace. Supplemental additions of carbon and oxygen to overcome the heat load on the system were also investigated. In all cases, the dust was chemically transformed, and the zinc content increased from 16% Zn to 60–80% Zn. About 50% of the zinc in the EAF dust dissolved in the iron or steel. The zinc oxide in the dust is thought to be reduced by carbon and the zinc vapour subsequently dissolved in the iron. A kinetic model for the dissolution process is proposed, and the implications for EAF dust recycling are discussed.

9:25 AM
Turning Blast Furnace Dust Into a Source of Zinc and Lead Units: A Progress Report on Testwork at Corus Ijmuiden: S. Honingh[1]; G. Van Weert[2]; M. A. Reuter[3]; [1]CORUS Iron Services, P.O. Box 10.000, 1970 CA, Ijmuiden, The Netherlands; [2]ORETOME, Ltd., 16668 Humberstation Rd., Caledon East, Ontario L0N 1E0 Canada; [3]Delft University of Technology, Delft, The Netherlands

Currently produced zinc-enriched blast furnace dust is stored on site at CORUS IJmuiden. To end this practise, a research program was started in 1996. Four technologies were studied: oxidative autoclave leaching in a chloride medium, fluid bed pyrohydrochloridisation (pyrohydrolysis) to yield lead-zinc-free (hematite) calcine, EAF (plasma) smelting/zinc fuming, and incorporation of the dust in iron foundry cupola charges. All aim to remove zinc and lead, recycle the iron residue internally, and produce a saleable zinc-lead product.

9:50 AM
Volatilization Kinetics of Zinc and Lead in Zn-Pb-Bearing Dust Pellets Containing Carbon: D. Y. Wang[1]; X. L. Shen[1]; D. R. Gu[1]; G. Y. Sha[1]; [1]Shanghai Baosteel Group Corporation, Kedong Rd., Baoshan District, Shanghai, China

The study of the volatilization kinetics of zinc and lead in pellets made of zinc-lead-bearing dust mixed with coal powder, in a nitrogen atmosphere and at a temperature range between 1100°C and 1300°C, shows that the reduction temperature has a significant effect on the volatilization rates of zinc and lead, and that both the particle size of the coal powder and the extra carbon content has no effect on the volatilization rates. The obtained activation energies for the volatilization of zinc and lead are 79.42kJ/mol and 88.74kJ/mol respectively. The volatilization rate of zinc is controlled by the reaction between the zinc oxide and carbon monoxide while that of lead is controlled by the lead evaporation reaction, and the diffusion of gaseous lead through the gas boundary layer covering the surface of the reduced liquid lead.

10:15 AM Break

10:45 AM
Recovery of Zinc Oxide from Secondary Raw Materials: New Developments of the Waelz Process: K. Mager[1]; U. Meurer[1]; B. Garcia-Egocheaga[2]; N. Goicoechea[2]; J. Rutten[3]; W. Saage[4]; F. Simonetti[5]; [1]B.U.S Berzelius Ummelt Service, Stresemannstrasse 80, Duisburg 47051 Germany; [2]Aser, Bilboa, Spain; [3]Recytech, France; [4]B.U.S. Zinkrecycling Freiberg, Freiberg, Germany; [5]Pontenossa, Italy

Because of the increasing use of zinc as an active and passive anticorrosion agent for steel, leading to constantly growing return rates of galvanized steel components, especially through the automotive industry, major Electric Arc Furnace (EAF) flue dust amounts with higher zinc contents will accumulate in future. Landfilling of steel plant flue dusts is no longer allowable for ecological reasons. These dusts are classified as hazardous by law. Waelz technology is safe and reliable. The range of treatable feed materials has been extended by process modifications and state-of-the-art offgas technology. Waelz oxide, the product, is delivered to metal smelters for zinc production and the byproduct, Waelz slag, can be used in road construction. Despite the fact that Waelz technology is among the best available techniques (BAT), it is continuously being optimized further with respect to energy input, product and offgas quality in order to comply with the ever more stringent environmental regulations. However, if these flue dusts are treated, the loops between the steel and the zinc industry can be closed by reusing recovered zinc which in turn leads to savings in natural resources and a more reasonable use of landfills.

11:10 AM
Operational Practice with the Waelz Kiln and Leaching Plant of TSU in Taiwan: A. L. Beyzavi[1]; C. Mattich[1]; [1]Lurgi Group of Companies, Frankfurt D-60295 Germany

The Waelz Plant at Taiwan Steel Union Co. Ltd. (TSU) was erected within nine months from September 1, 1998 to May 15, 1999. The nominal capacity of the plant is 50,000 tonnes per year of electric arc furnace dust (EAFD). The plant, consisting of material handling, a waelz kiln, a waste gas cleaning system, waelz oxide leaching and waste water treatment, was commissioned within three months from July 1, 1999 until October 12, 1999. The specific problem of the plant is the high chlorine content in the EAFD pellets which is up to 6%. Lurgi Metallurgie GmbH, Frankfurt, Germany was responsible for the engineering erection and commissioning of the plant.

11:35 AM
Production of Crude Zinc Oxide from Steel Mill Waste Oxides Using a Rotary Hearth Furnace: V. R. Daiga[1]; D. A. Horne[1]; [1]Maumee Research and Engineering, Inc., 8015 Rinker Point, Northwood, OH 43619 USA

Certain steel mill wastes contain significant amounts of zinc oxide due to the use of galvanized scrap during the steel making process. Typically electric arc furnace (EAF), and basic oxygen process (BOP) flue dusts contain 20 to 30% zinc oxide and 40 to 50% iron oxides, along with smaller quantities of lead and cadmium. These materials can be recovered from the flue dusts by using a proven rotary hearth furnace (RHF) process. By-products of the recycling operation include a crude zinc oxide fume which is captured in a baghouse filtering system, and sponge iron which may be recycled into the steel making operation. Crude zinc oxide properties plus the operating experience from two commercial RHF installations utilizing MR&E's DRyIron® Process will be presented.

Refractory Recycling

Wednesday AM — Room: LeBateau
October 25, 2000 — Location: Pittsburgh Hilton

Session Chairs: Charles E. Semler, Semler Materials Services, Tucson, AZ USA; Jeffrey B. Gorss, Alcoa, Inc., Knoxville, TN USA

9:00 AM
Overview of Refractory Recycling: R. T. Oxnard[1]; [1]Maryland Refractories Company, P.O. Box 267, Irondale, OH 43932 USA

The history of Refractory Recycling indicates there was little recycling until the 1950s. Energy incentives were the primary reason for the beginnings of a recycling effort by the refractory brick manufacturers. Quality benefits quickly became evident and fewer rejects were the result. Today, economic factors including higher valued raw materials and increased competition are the driving forces of refractory recycling. There are some success stories in refractory recycling but we have a long way to go. Few incentives, quality concerns, relatively cheap energy, comparatively lax government regulations, inexpensive landfills and inexpensive substitutes make recycling a difficult choice for many companies. Marketing advantages such as ISO 14000, eliminating multiple audits and reduced liability exposure can tip the scales toward recycling viability. Increasingly, the ideological philosophy of a company, a desire to minimize environmental impact and develop favorable public and other interested party perceptions can drive recycling and waste minimization efforts. Recycled materials can be more trouble "up front" and harder to "manage" due to their suspect quality. However, due to their nearly inexhaustible supply and the fact that once developed, they constantly contribute to the bottom line, they are certain to be the materials of the future. Waste refractory materials will likely see the same bright future as the steel scrap yards and slag piles of yesterday. In hindsight, we will realize that now was the perfect time to prepare and plan for the bright future of refractory recycling.

9:25 AM
Spent Refractory Recycling/Reuse Efforts in the Steel and Aluminum Industries: J. P. Bennett[1]; K. -S. Kwong[1]; [1]Albany Research Center, U.S. DOE, 1450 Queen Ave. SW, Albany, OR 97321 USA

Limited efforts have been made to recycle/reuse spent refractory materials in the steel and aluminum industries of North America. The driving force is usually part of a larger waste reduction program. Economic or legislative forces have not been a driving force for spent refractory recycling/reuse. Past and current spent refractory recycling/reuse practices will be reviewed, with emphasis on specific programs at steel and aluminum companies. Program goals and progress of the joint Office of Industrial Technologies-DOE/Steel Manufacturers Association program directed at spent refractory reuse with electric arc furnace steel producers will also be discussed.

9:50 AM
Modeling the Reuse of Spent Basic Refractory Material in an EAF: J. Kwong[1]; J. P. Bennett[1]; [1]Albany Research Center, U.S. DOE, 1450 Queen Ave. SW, Albany, OR 97321 USA

As concerns about the environment and the disposal of industrial wastes increase, the utilization of spent refractories from electric arc furnaces (EAF) is receiving more attention. Longer service life of refractories in an EAF can be achieved by foaming MgO saturated slag. The refractory wastes removed from a melt shop can be utilized as a part of these slags. The Albany Research Center is conducting research on recycling spent basic refractory materials as EAF slag conditioners. A good foaming slag should be a creamy, MgO saturated slag, which contains some solid particles (MgO-FeO). A computer model was developed to calculate the dual saturated slag chemistry with respect to CaO and MgO, the MgO saturated slag chemistry, and the solid content in solution. The effects of the C/S ratio, Al_2O_3, and temperature on the MgO-saturated slag as calculated by the model will be discussed.

10:15 AM Break

10:45 AM
Spent Refractory Waste Recycling from Non-Ferrous Metals Manufacturers in Missouri: J. D. Smith[1]; K. D. Peaslee[1]; [1]University of Missouri, Dept. of Cer. Eng., 222 McNutt, 1870 Miner Circle, Rolla, MO 65409-0330 USA

The 150 metal producers in Missouri generate approximately 8,000 tons of spent refractories each year, most of which is landfilled. Spent refractory samples were characterized and recycling/reuse techniques developed for some of the largest waste streams. Products using recycled materials are compared with products made from virgin materials.

11:10 AM Panel Discussion
Moderated by: Charles E. Semler and Jeffery B. Gorss

Secondary Lead - II

Wednesday AM — Room: Brigade
October 25, 2000 — Location: Pittsburgh Hilton

Session Chairs: Andreas Siegmund, RSR Technologies, Inc., Dallas, TX USA; Richard Leiby, East Penn Manufacturing Company, Lyon Station, PA USA

9:00 AM
Modernisation of the Lead Acid Battery Scrap Smelting Technology at "ORZEL BIALY" S.A.: S. Gizicki[1]; Z. Smieszek[1]; J. Czernecki[1]; G. Krawiec[1]; J. Porembski[2]; W. Dabrowicz[2]; J. Pawlowski[2]; [1]Institute of Non-Ferrous Metals, 5 Sowinskiego St., 44-101 Gliwice, Poland; [2]Orzet Bialy S.A., 98 Siemianowicka St., 41-902, Bytom, Poland

Rapid development of the automotive industry and motorization has been observed in Poland over the last decade. This phenomenon has increased the amount of used car batteries requiring recycling and has thus posed new challenges for their processing. "Orzel Bialy" S.A, is the major secondary lead smelter in Poland. This paper describes the program for smelting technology modernisation and productivity increase through the application of oxy-fuel burners, which has been implemented at "Orzel Bialy" S.A. The main objective of smelter modernisation, which was to increase the furnace productivity by 20%, has been achieved. This paper outlines the previous and present state of the lead acid battery scrap smelting technology at the "Orzel Bialy" S.A. Specifications of the burners and of oxygen installation are given. Industrial tests with the modernised smelting technology and optimisation of the process parameters are described, and the results obtained are discussed.

9:25 AM

Reduction of Lead in the Separator Fraction: U. Kammer[1]; H. Müller[2]; [1]Harz-Metall GmbH, Hüettenstrasse 6, Goslar D-38642 Germany; [2]UVR-FIA GmbH, Chemnitzer Strasse 40, Freiberg D-09699 Germany

The reduction of the lead content in the separator fraction produced during the mechanical processing of spent lead-acid batteries is an important environmental and economical issue. The reduction of lead down to less than 1 percent is very difficult using hydroseparators that are common in battery recycling facilities. Very promising results were achieved performing experiments on a test rig using a new technology in battery treatment: a discharge-type jigging unit. The materials is fed onto the jigging bed and transported through the machine. Due to the intensive movement of the feed, an additional washing effect is also obtained in addition to separation of the lead and plastic fractions. The knowledge gained from this development work at UVR-FIA GmbH in Freiberg, Germany, led to a patent application. This paper focuses on the results of the development work and the start-up and one year's operation of the industrial-scale application at Harz-Metall GmbH in Goslar, Germany.

9:50 AM

The Role of Electrochemistry at East Penn Manufacturing: R. Leiby[1]; M. Bricker[1]; R. A. Spitz[2]; [1]East Penn Manufacturing Company, Inc., Deka Rd., Lyon Station, PA 19536 USA; [2]Spitz Associates, 560 Bedford St., B-12, Abington, MA 02351 USA

Electrochemistry plays a significant role in minimizing wastes at East Penn's secondary lead smelter. East Penn has been recovering spent battery acid for reuse in new batteries since 1992. East Penn also produces a fertilizer feedstock from sulfur dioxide in the smelter stack gases. The success of these processes is, in large part, due to the installation of electrochemical cells. The cells in the acid recovery plant allow the waste from this process to be concentrated into less that 10% of the original spent acid. The cells in the fertilizer plant treat the solution to remove dissolved metals prior to sale to fertilizer manufacturers.

10:15 AM Break

10:45 AM

Viscosity Measurements of Lead Slags: R. G. Reddy[1]; Z. Zhang[1]; [1]The University of Alabama, Dept. of Metall. and Matls. Eng., Tuscaloosa, AL 35487-0202 USA

The viscosities of industrial lead slags with various compositions were measured as a function of temperature. It was found that viscosities of lead slags decreased with increasing temperature and the plots of ln(h) vs $10^4/T$ followed a linear relation over the reported ranges of temperature. Using the data of this study and available other related data from the literature, a viscosity expression was developed as a function of composition and temperature. The calculated results using this viscosity expression are in good agreement with the measured data. The composition dependency of viscosity of lead slags is discussed.

11:10 AM

CTP's Experience in the Removal of Contaminants and Odors in the Recycling Industry–A New Process for Simultaneously Removing VOCs and Dioxins and Furans: H. Thalhammer[1]; [1]CTP–Chemisch Thermische Prozesstechnik, Schmiedlstr. 10, Graz A-8010 Austria

During the refining of lead, copper or other metals the furnaces used in the process often produce waste gases. This paper illustrates how these waste gases can be successfully treated and destroyed by CTP 2-bed or multi-bed compact systems, modified for the additional reduction of dioxins and furans. The CTP regenerative thermal oxidizer also destroys VOCs (organic compounds and odours) using ceramic blocks as a heat exchanging media. The raw gas is forced through the ceramic beds where it is heated up to the oxidation temperature level. The VOCs, dioxins and furans are destroyed in the combustion chamber, subsequently generating water, CO_2 and heat. The hot purified gas heats up a second ceramic bed, which is used to preheat the raw gas after the valves have been switched. This process does not produce any secondary waste such as contaminated water, polluted air or any other products that have to be disposed of.

Aluminum Scrap Recycling - IV Process Analysis

Wednesday PM — Room: Ballroom 1
October 25, 2000 — Location: Pittsburgh Hilton

Session Chairs: Ray D. Peterson, IMCO Recycling, Inc., Rockwood, TN USA; Jan H.L. van Linden, Recycling Technology Services, Edgewood, PA USA

2:00 PM

Commercial Scale Melt Loss Testing: D. L. Stewart[1]; [1]Alcoa Technical Center, 100 Technical Dr., Alcoa Center, PA 15069 USA

Melt loss is usually one of the highest individual cost items in the operation of an ingot casting facility. While melt loss and the resulting cost for the entire facility is usually well known (at least via standard cost accounting), dross generation and melt loss for individual unit operations within the plant are usually not known. Thus, the financial impact of various practices, alloys and scrap types is not known. Development of an accurate, relatively low-cost technique for measurement of melt loss at commercial scale would aid in understanding melt loss for existing units, as well as evaluation of the melt loss impact of alternate processes. This paper will describe a methodology developed at Alcoa for accurate and inexpensive measurement of melt loss at commercial scale. The methodology has been used to evaluate the impact of scrap type, melting practices, and dross treatment technology on melt loss.

2:25 PM

Dross Analysis Methods and Their Application for Evaluating Secondary Furnace Operations: R. D. Peterson[1]; A. S. Revet[2]; [1]IMCO Recycling, Inc., 397 Black Hollow Rd., Rockwood, TN USA; [2]IMC Potash, Belle Plaine, SK, Canada

The optimization of secondary aluminum furnaces is critical to the efficient operation of a recycling facility. Since all metal loss occurs in the drosses, physical and chemical analyses of these by-products are valuable diagnostic tools. Dross analyses can provide information concerning total furnace metal recovery efficiency as well as identifying areas for potential improvements. A complete dross analysis is a labor-intensive process that requires significant care both in sampling and performing the analytical techniques. Experiments can be done at a bench- or plant-scale depending on the facilities available. This paper outlines the benefits and information that can be generated through dross studies. Furthermore, several analytical methods are discussed as well as the special requirements needed to gain accurate results. Experimental data from industrial studies is provided to demonstrate the use of dross evaluations for furnace optimization.

2:50 PM

Aluminum Sidewell Melting Furnace Heat Transfer Analysis: R. F. Jenkins[1]; [1]Thorpe Technologies, Inc., P.O. Box 1759, Gulf Shores, AL 36547-1759 USA

This document addresses the use of practical and basic engineering principles to develop a computer model for the analysis of the various issues which affect heat transfer in aluminum sidewell furnaces. These issues include furnace charge conditions, furnace operating conditions, furnace general arrangement, furnace combustion conditions, and furnace ambient heat loss. The engineering principles applied to this model were first put to test over 20 years ago. A prototype computer model developed 12 years ago has been in continuous use by Thorpe Technologies to determine the performance of sidewell furnaces for the aluminum industry. A new computer model has enhanced capabilities for more detailed performance analysis including regenerative and oxygen enriched combustion.

3:15 PM Break

3:45 PM

Historical Data Analysis in Quality Improvement of Aluminum Recycling Process: A. R. Khoei[1]; I. Masters[2]; D. T. Gethin[2]; [1] Sharif University of Technology, Dept. of Civil Engineering, P.O. Box 11365-9313, Tehran, Iran; [2]University of Wales Swansea, Dept. of Mech. Eng. Dept., Singleton Park, Swansea, SA2 8PP UK

This paper describes an experimental investigation into the effects of process parameters on product quality during an aluminum recycling process. In order to build a model relating recovery to the process parameter variables and then use the model for prediction, process optimisation, or process control, a historical data analysis is employed by observing patterns in the datalogged information at IMCO Recycling Ltd. In previous work, we emphasised the importance of expressing the results of an experiment quantitatively, by implementation of a Taguchi approach, to facilitate understanding, interpretation and implementation. This research presents the technical tools that are needed to achieve quality improvement in recycling of aluminum. In this study we apply the use of historical data matching through a Taguchi orthogonal analysis, in order to control and improve the quality characteristic. For this purpose, a numerical model is developed to characterise the inputs and outputs of the process. A response surface methodology (RSM) is employed to find a suitable approximation for the true functional relationship between response and the process parameter variables. The method of least squares is used to estimate the approximating polynomials. Subsequently, Taguchi's method is used to determine the relative significance of each of the parameters. Finally, process management software (written in Visual Basic) is described, and its interface with the process modelling and optimisation routines is discussed.

4:10 PM

Experimental Study on Aluminum Scrap Recycling: Y. Xiao[1]; M. Reuter[1]; P. Vonk[1]; J. Vonken[1]; H. Orbon[2]; T. Probst[2]; U. Boin[2]; [1]Delft University of Technology, Dept. of Appl. Earth Sci., Mijnbouwstraat 120, 2628 RX, Delft, The Netherlands; [2]BAS Brinker Aluminum-Schmelzwerk GmbH, Am Brinker Hafen 4, Hannover D30179 German

Although secondary aluminum industry is well established in the world, the recycling process still requires further development to adequately control the process for a higher aluminum yield and a better product quality. In the present paper, recyclabilities of different aluminum scraps have been experimentally studied. Four types of commercial scraps were characterized and melted at 800-900°C to recover aluminum metal with the protection salt flux of NaCl-KCl-Na_3/AlF_6 under nitrogen atmosphere. According to the results, the difficulty of recycling aluminum scrap depends on the cleanness and the ratio of surface area to body volume. More non-metallic contaminates and higher ratio of surface area to body volume usually led to a lower metal yield. Usually cast ingots gave better results than rolling mill cuttings under similar conditions. Bottle caps can be recycled more easily than the margarine foil. The effect of temperature was not as significant as the composition of salt flux. The addition of cryolite was essential for a better metal recovery, especially for the scraps with higher surface area.

4:35 PM

Metal Values from Used Beverage Cans: M. A. Rabah[1]; [1]Central Metallurgical R&D Institute, Indust. Wastes Lab., P.O. Box #87, Helwan 11421, Cairo, Egypt

In this work, metal values were prepared from used beverage cans. The cans are made of aluminum and minor alloying metals and printed with a multi-color printing ink. A method has been investigated to remove the printed coating using organic solvents or by sand blasting technique in a rotating drum. Metal values of the cleaned cans are prepared applying combined hydro and pyrometallurgical treatments. Factors affecting the efficiency of the suggested method have been studied. The results show that the extent of removal of the printing coating is successfully performed with recyclable methyl ethyl ketone/dimethyl formamide mixture. With sand blasting, it proceeds regularly with the inner diameter, the rotation speed of the drum, the size of the sand grains and temperature. The removed coating is stripped with the same solvent. Metal alloys(s) are prepared in two ways. In the first way, the cans are pressed into solid blocks using hydraulic press before melting at temperatures up to 1000°C using borax-sodium chloride salt mixture as a flux. The quality of the metal obtained is a function of the salt and temperature. The slag so formed was leached with mineral acid solutions. In the second way, the used beverage cans are directly dissolved in mineral acids whereby different metal values are selectively precipitated. The undissolved part is fused with sodium carbonate at 800°C and processed in the same manner. Results were explained in the light of the thermodynamic properties of the species involved.

EAF Dust Processing - III

Wednesday PM — Room: Kings Gardens
October 25, 2000 — Location: Pittsburgh Hilton

Session Chairs: James C. Daley, Daley & Associates, Phoenix, AZ USA; R. R. Bleakney, INMETCO, Ellwood City, PA, USA

2:00 PM

Treatment of Secondary Zinc Oxides for Use in an Electrolytic Zinc Plant: S. S. Chabot[1]; S. E. James[1]; [1]Big River Zinc Corporation, Rt. 3 & Monsanto Ave., Sauget, IL 62201 USA

A recent survey of CEOs from major steel companies worldwide revealed the importance of recycling zinc units from EAF dust, mill scale, blast furnace dust, and other zinc containing streams in their plants. Many processes were developed and installed in response to this challenge. The most successful approach involves the production of a crude zinc oxide and its sale to primary zinc producers to recover the metal values. The problem with this process is the high concentration of halides in the crude oxide. This type of material cannot be processed directly in an electrolytic zinc plant because of the corrosion problems it will cause in electrolysis. In 1999, BRZ installed a zinc oxide receiving and washing plant to minimize the impact of halides in its circuit. A description of the washing plant and the initial operating results are included.

2:25 PM

Processing Steel Wastes Pyrometallurgically at INMETCO: K. L. Money[1]; R. H. Hanewald[1]; R. R. Bleakney[1]; [1]The International Metals Reclamation Company, Inc., P.O. Box 720, 245 Portersville Rd., Ellwood City, PA 16117-0720 USA

The processing of EAF baghouse dusts, rolling mill scales, and belt grinding swarfs from the specialty steel industry will be reviewed. In addition, the INMETCO process has been modified so as to recover nickel, chromium, and iron from many other waste materials such as pickling solutions, filter cakes, spent nickel and chromium plating baths, super alloy wastes, and nickel-cadmium batteries. INMETCO is the only North American company presently capable of recycling nickel-cadmium batteries by high temperature metals recovery.

2:50 PM

Processing of Zinc-Containing Wastes with the Liquid-Phase Reduction Romelt Process: V. Valavin[1]; V. Romenets[1]; Y. Pokhvisnev[1]; S. Vandariev[1]; A. Yatsenko-Juk[1]; [1]Moscow State Institute of Steel and Alloys, Leninsky Prospekt 4. MISA, Moscow 117936 Russia

The technology of the liquid-phase reduction process known as Romelt was developed in the Moscow Institute of Steel and Alloys in 1979. The pilot plant was constructed at the Novolipetsky Steel Works (Russia) in 1984. Investigations into processing zinc-containing blast oxygen furnace dust and slag from the Lead and Zinc Works at the pilot Romelt plant proved the perspective of using this technology for processing zinc and lead-containing materials. In this article, the description of Romelt technology, basic technological information of trials at the Romelt plant using zinc-containing materials, compositions of charging materials, metal, slag, gas and dust are presented. The influence of flue gas composition on the composition of zinc containing dust is shown.

3:15 PM Break

3:45 PM

EAF Dust Recycling at AmeriSteel: J. D. Sloop[1]; [1]AmeriSteel Dust Processing Division, 801 AmeriSteel Rd., Jackson, TN 38305 USA

This paper discusses the current state of EAF dust recycling at AmeriSteel's Dust Processing Division in Jackson, Tennessee. Included are a brief history of the plant, a description of the facility, a description of the process, and operating data.

4:10 PM

Recycling EAF Dust with CONTOP® Technology: F. Sauert[1]; U. Kerney[2]; J. Pesl[1]; [1]Voest-Apline Industrienlagenbau GambH and Company, Turmstrasse 44, P.O. Box 4, 4031 Linz, Austria; [2]Harzer Zink Gamb, Landstrasse 93, 38644 Goslar, Germany

The CONTOP® smelting cyclone is a water-cooled, upright, high-intensity smelting reactor. The technology for the reactor was initially developed and brought into industrial-scale operation in the area of non-ferrous metallurgy. The two largest smelting cyclones were built with a capacity of 32 tons per hour of copper concentrate mix. The newest industrial CONTOP® plant treats up to five tons per hour of zinc-bearing residues including EAF dust. The highly concentrated zinc-lead oxide produced is sold to the zinc industry. The slag fulfills the leaching criteria and is used in waterway construction. The heat transferred to the cyclone cooling system and the off-gas boiler produces steam from which power is generated in a turbine. VAI has erected a new CONTOP® demonstration plant at MEFOS, Luleå, Sweden. A zinc volatilization rate of 90% was achieved during hot commissioning with Swedish EAF dust. Treatment costs in the range of 85 to 100 EUR per ton were estimated in a feasibility study on the treatment of 73,000 and 57,000 tons EAF dust for a group of steelmaking mills in Southern Europe.

4:35 PM

Electrolytic Zinc Production from Crude Zinc Oxides with the Ezinex® Process: M. Olper[1]; M. Maccagni[1]; [1]Engitec srl, Via Borsellino e Falcone 31, Novate, Milanese 20026 Italy

The crude zinc oxides (CZO) produced in any thermal process dealing with EAF dust also contain lead, cadmium, and a considerable amount of halides (chlorides and fluorides). The high halide contents make these crude zinc oxides less and less attractive, both technically and economically, and a further refining procedure is necessary to meet the zinc and zinc oxide market requirements. Hydrometallurgical techniques commercially used to dehalogenate the crude zinc oxides are not effective enough to upgrade the crude zinc oxides to the required specification for their direct use in the traditional sulphuric electrolysis by primary zinc producers. The EZINEX® PROCESS has solved the problem of the halides contained in the crude zinc oxides. This process is the only proven technology electrowinning zinc from a chloride-based electrolyte in a conventional cell house. This paper discusses the process economics taking the data from feasibility studies of different size commercial plants.

Magnesium Recycling

Wednesday PM — Room: LeBateau
October 25, 2000 — Location: Pittsburgh Hilton

Session Chairs: James C. Daley, Daley & Associates, Phoenix, AZ USA; Robert E. Brown, Magnesium Monthly Review, Prattville, AL USA

2:00 PM

Magnesium Recycling Yesterday, Today, Tomorrow: R. E. Brown[1]; [1]Magnesium Monthly Review, 226 Deer Trace, Prattville, AL 36067 USA

Magnesium recycling has been used to recover both new scrap and old scrap. It was used extensively in Germany during WW II to expand the magnesium supply. There were a large number of magnesium recyclers in the US who got their start smelting old scrap, old airplanes, and old waste dumps from the WWII build up. As the world magnesium industry dwindled, only a few companies were left that did magnesium recycling as a primary business. The sand foundries tended to recycle of their production scrap in their melting furnaces. Even the original die casters tended to put scrap directly back into melting furnaces at the die casting machines. As high purity alloys were developed and the use of die castings in automotive work increased, the tendency was to let the magnesium recyclers convert the scrap back to high quality ingot. Automotive use has grown because of the low density of magnesium. This property is one of the biggest problems to overcome in shipping scrap. Gates and runners from die casting are very irregular shapes and it is very hard to load a truck with enough material to get a low shipping cost per pound. Recent new equipment companies have developed magnesium equipment that is specifically designed to recycle, refine and cast secondary magnesium metal. These metal cells are supplied as integrated units to magnesium casting sites. The cost and effectiveness of this approach will be discussed.

2:25 PM

Addressing Some of the Key Recycling Issues in the Magnesium Industry with Integration of Primary Metal Production, Die Casting and Recycling: M. Rejaee[1]; P. Steeneken[2]; [1]Hydro-Terra, Inc., 3333 Queen Mary Rd., Montreal, Quebec H3V 1A2 Canada; [2]Antheus Magnesium, P.O. Box 424, Groningen 9700 AK The Netherlands

The automotive industry's search for increased fuel efficiency through component weight reduction has driven the growth in consumption of magnesium metal in the form of die cast alloys. This trend, which began in North America and should soon accelerate in Europe, will require enhanced recycling services since each tonne of metal used for die cast parts production produces about 500 kg of scrap. Currently, the European die cast market is plagued by very high tolling prices for scrap recycling due to lack of competition and high transport costs due to the distances between the scrap generator and the recycling facility. This situation clearly increases the cost of magnesium die cast components and reduces magnesium's competitiveness with other materials. The challenge for the magnesium industry in the short term is to provide cost effective recycling solutions for the die cast industry. In addition effective recycling, in the medium to long term, is needed for the anticipated large volumes of secondary or used scrap that will become available as the die cast components reach the end of their life cycle. This paper will present The Antheus Integrated Magnesium Project as a Novel approach addressing some of the key recycling related issues facing the magnesium industry, in particular the die casters. The paper outlines the many advantages of an integrated magnesium metal park, in an overall goal of increasing magnesium metal's competitiveness.

2:50 PM

Preparation of Secondary Magnesium for Use in Hot Metal Desulfurization: M. R. Dahm[1]; [1]Reactive Metals & Alloys Corporation, Rte. 168, P.O. Box 366, Pittsburgh, PA 16160 USA

The demand for low sulfur steel by steel manufacturers and their customers has been steadily increasing for 25 years. Historically sulfur has been controlled by various means and with various additives but lime-magnesium external desulfurization of hot metal has become established as the dominant method in North America today. Magnesium powder produced from primary magnesium ingot has been the major source or raw material. However, periodic increases in the price of this commodity have encouraged producers to look to secondary magnesium for an alternate source of magnesium. Secondary magnesium from post-consumer scrap can be cleaned, sized, and prepared to produce a high quality magnesium reagent for use in hot metal desulfurization at a lower cost than material processed from primary ingot.

3:15 PM Break

3:45 PM

Remelting of Magnesium Type 1 Scrap With or Without Flux?: A. Ditze[1]; C. Scharf[1]; [1]Institut für Metallurgie, Robert-Koch-Strasse 42, 38678 Clausthal-Zellerfeld, Germany

Magnesium type 1-scrap can be remelted without flux in the presence of different sulfur containing protective gases. Beside the draw back in the use of these gases, that either are contributing to the global warming potential GWP (SF_6) or are poisonous (SO_2, residues like dross and crucible sludge are produced. Dross and sludge now a days must be utilized. Partly these byproducts can be used in the aluminum industry and partly for desulphurization of hot metal and steel. Another possibility is melting of dross and sludge with flux for the production of a secondary magnesium alloy. Then again residues are generated that must be processed. Therefore, the whole material cycle has to be considered to decide which kind of utilization practice is optimum. Based on experiments this question is discussed and the material balances for fluxfree melting, melting with flux and fluxfree melting plus other utilization of the residues are presented.

Spent Catalyst Recycling

Wednesday PM — Room: Brigade
October 25, 2000 — Location: Pittsburgh Hilton

Session Chair: Robert L. Stephens, Cominco Research, Trail, British Columbia, Canada

2:00 PM

Recovery of Non-Ferrous Metals from Spent Catalysts: C. S. Brooks[1]; [1]Recycle Metals, 145 S. Mill Dr., South Glastonbury, CT 06033 USA

This paper undertakes to assess what opportunities exist for the economical recovery of non-ferrous metals from spent catalysts. The most promising recovery appears to lie with metals such as Co, Mo, Ni, W, heterogeneous catalysts used on a large scale in petroleum processing. Nickel is a metal with diverse applications on a large scale notably in hydrocarbon steam reforming and in vegetable oil hydrogenation. In addition, several of the precious metals, notably Pt, Pd, Rh, find extensive use in fossil fuel processing and in automotive and power plant flue gas control. The hydrometallurgical and pyrometallurgical alternatives for processing are identified and discussed, especially with citations to illustrate reduction to commercial practice. Promising directions for adaptation of appropriate, economic separation technologies for recovery of non-ferrous catalytic metals generated in significant amounts for the secondary metal markets are identified.

2:25 PM

Evolution of GCMC's Spent Catalyst Operations: Z. R. Llanos[1]; W. G. Deering[1]; [1]Gulf Chemical and Metallurgical Corporation, P.O. Box 2290, Freeport, TX 77542 USA

Gulf Chemical and Metallurgical Corporation (GCMC) has been operating facility for treatment of spent catalysts in Freeport, Texas since 1974. Recently, GCMC expanded its operations with the addition of an electric furnace for the production of fused alumina and mixed alloys. GCMC and its affiliate Sadaci, started up a new pre-treatment facility in Ghent, Belgium in 1998. GCMC is also part owner of Bear Metallurgical Corporation, a major producer of ferroalloys in the United States. This paper reviews the processes at these facilities. Changes in the management of hydrotreating and hydrorefining spent catalysts are discussed in light of recently issued federal regulations that made the majority of spent catalysts a listed hazardous waste.

2:50 PM

Novel DC Furnace Design for Smelting Nickel and Cobalt Bearing Concentrate from Spent Alumina Catalyst: S. de Vries[1]; N. Voermann[1]; T. Ma[1]; B. Wasmund[1]; J. Metric[2]; S. Kasinger[1]; [1]Hatch, 2800 Speakman Dr., Mississauga, Ontario L5K 2R7 Canada; [2]Gulf Chemical and Metallurgical Corporation, 302 Midway Rd., Freeport, TX 77541 USA

Gulf Chemical & Metallurgical Corporation (GCMC) operates a circular DC electric smelting furnace to treat nickel and cobalt bearing residues at its plant in Freeport, Texas. The furnace, originally built by others, has experienced problems including runouts through the hearth and the lower sidewall. Hatch has designed several improvements to the furnace to alleviate these problems. The single anode at the center of the hearth was replaced with a patented system of twelve air-cooled copper side anodes evenly spaced around the furnace perimeter. The water-cooling system on the bottom and lower sidewall shell plates was replaced with an air-cooling system using copper cooling fins. The existing row of water-cooled copper coolers in the metal bath zone were redesigned for greater thermal capacity and better element joint sealing, and a new row of water-cooled copper coolers was added to cool both the alumina bath and freeboard zones. The existing water-cooled metal and alumina tapblocks were also redesigned for more robust cooling. A binding system was added to provide refractory compression to help reduce the chance of liquid leaks. Finally, the furnace tilting frame was relocated to the top of the furnace where it is less likely to be damaged.

3:15 PM Break

3:45 PM

Recovery of Vanadium, Molybdenum, Nickel, and Cobalt from Spent Catalysts: A New Processing Plant in China: M.-V. Wang[1]; [1]Quanzhou Jing-Tai Industry Company Limited, Xiaocuo Ling-Co Industry Zone, Nanpu Town, Quan-Zhou City, Fujian Province 362114 China

Hydrotreating and hydrorefining (HT and HDS) spent catalysts contain molybdenum, vanadium, nickel or cobalt at concentration levels that can make metals recovery economically viable. Quanzhou Jing-Tai of China has developed, through many years of operating experience in metal recovery from spent catalysts, a simple process for recovery of these metals and the production of environmentally benign residues. The process first subjects the catalysts to a low-temperature calcination step, followed by grinding of the calcine. The ground material is then leached with 10-20% v/v hydrogen peroxide to recover metals such as Mo, V and Ni or Co. This step has a selectivity that is greater than 95% for the metals. The undissovled residue, which contains mainly Al_2O_3 and SiO_2, can be dewaterd and used in the production of masonry bricks. The pH of the rich liquor is then adjusted to between 0.5 and 2.5 by adding dilute sulfuric acid to co-precipitate Mo and V, with a recovery rate of greater than 99%. The lean liquor contains mostly dissolved Ni or Co, which can be recovered through precipitation at a pH of between 8.5 and 9.5 by caustic additions. The final liquor is then sent to an ion exchange step for final recovery and cleanup of residual metals. The effluent is then discharged after a simple wastewater treatment process, which has been found to meet all environmental requirements. The entire process has been found to be simple, cost-effective with minimal environmental impacts while achieving the goal of complete resource recovery from spent catalysts commercially.

4:10 PM

Reactor Design for Nickel Recovery from HDS Waste Catalyst: G. Plascencia-Barrera[1]; J. G. Gutiérrez-Paredes[1]; F. Reyes-Carmona[2]; [1]ESIQIE-IPN, Depto. de Ing. Metalúrgica, UPALM Edificio 7, México D.F., 07330 México; [2]UNAM, Depto. deIng. Metalúrgica, Facultad de Química, Edificio D, C. U., México D.F., 04420 México

In Mexico, many tonnes of nickel from waste petrochemical catalysts are dumped every year. In order to recover all that nickel, a hydrometallurgical reactor was designed. This design was performed in a systematical fashion, which included the chemistry of the system under study, both a kinetic and mass transfer study, and finally the use of the RTD function, to optimize the reactor size. It was found that the NiO leaching with sulfuric acid is well represented by a first order reaction. The mass transfer results are in good agreement with the experimental results, obtaining over 95% nickel extraction in both cases. A marketing study was also completed that determined that it is possible to make a good profit by processing this residue provided the capital cost was low.

Index

Fourth International Symposium on Recycling of Metals and Engineered Materials

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

Notes

Notes