

MONDAY, AUGUST 25, 2003, P.M.

SESSION 1: SECOND INTERNATIONAL SYMPOSIUM ON ECOMATERIALS AND ECOPROCESSES

GLOBAL ENVIRONMENTAL POLICY INITIATIVES

Sponsor: Materials Science and Engineering

Room: Orca

Chairman: H. MOSTAGHACI, Science and Technology Division, Department of Foreign Affairs and International Trade, Ottawa, Ontario, Canada

PAPER 1.1 — 14:00

IMPACT OF ENVIRONMENTAL ISSUES IN MATERIALS SCIENCE.

T.K.S.P. GUPTA and S.S. VERMA, Department of Physics, Sant Longowal, Institute of Engineering and Technology, Sangrur, India

Our modern technologies and the manufacturing of their associated products impact our societies in a variety of ways - some are positive, others are adverse. Furthermore, these impacts are economic and environmental in type. Correcting any environmental problems associated with manufacturing will influence product price. That is, manufacturing cost is normally greater for a “green” (or “environmentally friendly”) product than for its equivalent that is produced under conditions wherein environmental issues are minimized. Thus the economics of engineering is very important in product design and manufacturing. In this paper, economic factors are also discussed; environmental and societal impacts of production are becoming significant engineering issues. In this regard, the material cradle-to-grave life cycle is an important consideration; this cycle consists of extraction, synthesis/processing, product design/manufacture, application, and disposal stages. Materials, energy, and environmental interactions/exchanges are important factors in the efficient operation of the materials cycle. The earth is a closed system in that its materials resources are finite; to some degree, the same may be said of resources. Environmental issues involve ecological damage, pollution, and waste disposal. Recycling of used products and the utilization of green design obviate some of these environmental problems. Recyclability and disposability issues are discussed in the context of materials science and engineering. Ideally, a material should be at best recyclable, and at least biodegradable or disposable.

PAPER 1.2 — 14:25

EFFECT OF TRANSPORTATION ON THE ECOSYSTEM.

J.A. CARPENTER, Jr., U.S. Department of Energy, Washington, District of Columbia, U.S.A.

Transportation of goods and people affects the ecosystem in six ways: (1) obtaining the raw materials for the infrastructure and the vehicles; (2) providing the power for motivating the vehicles; (3) appropriating land for the infrastructure; (4) constructing the infrastructure and manufacturing the vehicles; (5) using the vehicles; and (6) disposing of the infrastructure and vehicles. In most parts of the world, (2) and (5) are of main concern, and are thus focussed upon in this paper. The main ecological problems are associated with the combustion of fossil-fuels. And, as the world continues its trends toward more people and greater affluence, the problems could increase — catastrophically some warn. However, current and foreseen future technologies should be quite capable of ameliorating or eliminating most ecological concerns about transportation, and some of these technologies will be discussed. However, the ultimate factors influencing implementations of the technologies are likely to be economic and political.

PAPER 1.3 — 14:50

INVESTIGATION ON ENVIRONMENTAL IMPACT EVALUATION METHOD RELATED TO ENVIRONMENTAL MANAGEMENT SYSTEM FOR POTENTIAL EMERGENCY SITUATION.

K. IWADARE, Tokyo Institute of Technology, Yokohama, Japan,

N. MIFUNE, S. ENDO and H. NOZAWA, Railway Technical Research Institute, Tokyo, Japan

In order to reduce the environmental loads, organizations have been using ISO 14001, a widely used environmental management systems (EMS). One of the requirements of ISO 14001 is that identifying potential emergency situations which may impact the environment. Results of the environment impact evaluation for emergency situations are used in order to decide the significant environmental aspects (SEAs). Because SEAs may cause serious significant situations, emergency situations have to be evaluated by using a reasonable evaluation method. So a new evaluation method is investigated in this paper.

COFFEE BREAK — 15:15 – 15:45

PAPER 1.4 — 15:45

DEVELOPING SUSTAINABLE RESOURCE RECOVERY AND RECYCLING.

M. CLAPHAM, Resource Recovery and Recycling, Natural Resources Canada, Ottawa, Ontario, Canada

This paper will explore issues to be addressed in the development of resource recovery and recycling initiatives, which lead to significant increases in the recovery of products and materials at end-of-life. Taking a life cycle approach, the paper will explore how issues such as design for environment, consumption patterns, sustainable markets for recovered products, infrastructure, policy mechanisms and technology can influence recovery rates. The benefits of increased recovery, such as materials and energy efficiencies, reduced burdens to landfill, greenhouse gas emissions and social implications will be discussed. Examples of Canadian activities within the resource recovery and recycling sector will be provided.

PAPER 1.5 — 16:10

FUTURE AUTOMOTIVE TECHNOLOGY.

R. SULLIVAN, J.A. CARPENTER, Jr. and D. HAMILTON, U.S. Department of Energy, Washington, District of Columbia, U.S.A.

Automotive technology is in the beginning of an era of innovation not seen since the early part of the 20th century. Hybrid power plants consisting of spark-ignited engines and electric motors are already in production cars sold in Japan, North America and Europe. Cars with virtually all aluminum bodies and chassis are also available. And, there is much more to come. Cars the size of the typical American family sedan getting 33 km/L (approx. 80 miles per U.S. gallon) of gasoline or better will become commonplace. Virtually every major world automaker is working on vehicles powered by fuel cells. And, as these advances come to fore, they will undoubtedly challenge old paradigms and open opportunities for new. This paper will present an overview of some of the things happening in automotive technology and attempt to discern what the ramifications may be.

PAPER 1.6 — 16:35

EMERGING WASTE REDUCTION TECHNOLOGIES FOR THE DESIGN AND CONSTRUCTION OF BUILDINGS.

S. DEBES-KANHO, B. KYLE, M. CHEUNG and S. FOO, Facilities Life-Cycle Management Technology, Public Works and Government Services Canada, Ottawa, Ontario, Canada

The construction sector is one of the largest contributors to Canada's solid waste disposal stream. Public Works and Government Services Canada (PWGSC) is investigating, developing and implementing various techniques to reduce the adverse impacts resulting from conventional design and construction practices. A set of comprehensive improvements to the design processes, maintainability and serviceability of building systems, in order to enhance disassembly possibilities, is described within this paper. Waste diversion practices including the recycling of concrete, steel, non-ferrous metals, gypsum and wood are examined. Technical and economic consequences associated with implementing the recommended procedures are identified and discussed.

PAPER 1.7 — 17:00

STUDY ON AN ENVIRONMENTAL PERFORMANCE EVALUATION FOR THE 2002 FIFA WORLD CUP SOCCER MATCH.

Y. ISHIDA, Tokyo Institute of Technology, Yokohama, Japan,

N. MIFUNE, S. ENDO and H. NOZAWA, Railway Technical Research Institute, Tokyo, Japan

Development of the evaluation method is investigated in this paper, regarding comparisons of environmental loads among different kinds of businesses. As a result, the developed new evaluation method can provide the numerical comparison data between the 2002 Federation Internationale de Football Association, FIFA World Cup soccer match and a rubber manufacturing factory.

TUESDAY, AUGUST 26, 2003, A.M.

SESSION 11: SECOND INTERNATIONAL SYMPOSIUM ON ECOMATERIALS AND ECOPROCESSES

DESIGN MATERIALS FOR ENVIRONMENT

Sponsor: Materials Science and Engineering Section,

The Metallurgical Society of CIM

Room: Orca

Chairman: T. TROCZYNSKI, Department of Metals and Materials Engineering, The University of British Columbia, Vancouver, British Columbia, Canada

PAPER 11.1 — 8:30

LEAD-FREE ENVIROBRASS — AN ENVIRONMENTALLY FRIENDLY ECOMATERIAL.

M. SADAYAPPAN, L.V. WHITING and M. SAHOO, Materials Technology Laboratory (CANMET), Ottawa, Ontario, Canada

Lead is considered to be one of the metals affecting health of human being after prolonged exposure. The possible ways of lead absorption to human body is by inhalation and ingestion. Plumbing components are traditionally made from copper alloys containing 4% to 8% lead. Lead is known to improve pressure tightness and machinability of these alloys making them economically viable. However, recent regulations, imposed by Canadian and United States environmental agencies, on the maximum allowable lead content in drinking water make leaded copper alloys unsuitable for such applications. Research conducted at MTL developed copper alloys containing bismuth and selenium as alternatives for leaded alloys. This paper discusses the development of the new alloys and their impact on foundry industry, recycling, and the health of the public.

PAPER 11.2 — 8:55

FORMATION OF NiAl INTERMETALLIC COATINGS ON STAINLESS STEEL BY A CONVENTIONAL DUPLEX PROCESS.

F. ASHRAFIZADEH, Department of Materials Engineering, Isfahan University of Technology, Isfahan, Iran, and S.N. ASHRAFIZADEH, Department of Chemical Engineering, Iran University of Science and Technology, Tehran, Iran

Nickel-aluminide coatings were formed on stainless steel 403 samples by a duplex process followed by diffusion annealing treatment. Nickel coatings were electro-deposited on some specimens prior to aluminizing. Process parameters including pack composition, temperature, coating, and annealing cycles were optimized in terms of the intermetallic phases produced in the near surface layers. The coatings and interface regions were characterized by optical and scanning electron microscopy, X-ray diffraction and glow discharge optical spectroscopy. Experimental results indicate addition of a nickel interlayer before aluminizing produces two distinct layers of NiAl and FeAl on the surface and below that, respectively. The intermetallic phase, NiAl, on steel substrate acts as an alumina-forming material and, thus, the duplex coating exhibits remarkable oxidation resistance at high temperatures. The results suggest that nickel-aluminide coatings can be suitable candidates for high-temperature applications of steel components.

PAPER 11.3 — 9:20

Characterization of Plasma Sprayed NiAl Intermetallic Compound Coating Mechanical Alloyed Powders.

M. SALEHI, H. EDRIS and M.M. JAVADI, Isfahan University of Technology, Isfahan, Iran

In this research the possibility of plasma spraying of mechanically alloyed powders has been studied. In this respect, the effect of plasma spray process parameters on the formation of NiAl intermetallic compound coatings by using a previously mechanically alloyed nickel and aluminum powders were examined. Microstructural analysis including XRD, SEM, and EDAX were used to identify the developed phases and microstructure of coating. The results showed that mechanical alloying is a prerequisite process for the formation of NiAl intermetallic compound coating. The studies also showed that the spray distance has a pronounced effect on the quality of the coating. The optimum distance for the minimum porosity content was determined. Furthermore, deviation from the optimum spray distance has led to the formation of oxide inclusions.

PAPER 11.4 — 9:45

EFFECT OF SILICA FUME ON THE BEHAVIOUR OF BURNT CLAY-LIME PASTES.

M.A. TAHER, Department of Chemistry, Faculty of Science, Al-Azhar University, Cairo, Egypt

Silica fume has a significant effect on the hydration process of tricalcium silicate (C_3S) by lowering the concentration of Ca^{+2} and OH^- in liquid phase. The effect of partial substitution of burnt clay (mixed type) with silica fume in the presence of lime [$Ca(OH)_2$] was studied in this investigation. Mixed type clay (Kafr Homid, Egypt) was activated by burning at $900^\circ C$ then mixed with lime (constant weight ratio, 30%) and silica fume (different weight ratios). The specimens after molding were hydrothermally treated at 10 atmosphere for periods of 2, 12, and 24 hours. The change occurring in the physico-chemical properties were investigated by compressive strength, chemically combined water, bulk density, and free lime contents measurements. Also, the change in morphology and microstructure of some hardened pastes were investigated using SEM tests. The results of this study indicated that replacement of burnt mixed type clay by 5% silica fume in the presence of lime improve the compressive strength at all ages, while replacement by 20% silica fume enhance compressive strength. This could be attributed to additional tobermorite gel (CSH phase) which formed due to the reaction of silica fume with $Ca(OH)_2$.

COFFEE BREAK — 10:10 – 10:40

PAPER 11.5 — 10:40

SiO₂/SiO₂-ZnO OPTICAL COATINGS FABRICATED BY THE SOL-GEL METHOD.

A. GHASEMI, R. MOZAFFARINIA, F. ASHRAFIZADEH and M.A. GOLOZAR, Department of Materials Engineering, Isfahan University of Technology, Isfahan, Iran

A Sol-Gel-based coating technology has been developed for making multilayer ceramic coatings. The coatings are SiO₂ and SiO₂-ZnO composites made by dispersing ZnO powders in Sol-Gel solution. SiO₂/SiO₂-ZnO multilayer stacks were alternately coated on glass soda-lime substrate. Investigations of the structure and coating analysis were carried out and durability of coatings in different environment were evaluated. Reflected spectrums from surface coatings were prepared and optical behaviour of layers has been studied. The results indicated that Sol-Gel process can be used to produce completely stable ceramic multi-layer coatings. Analysis of reflected spectrum also indicated that with an increase in the numbers of alternate layers of SiO₂ and SiO₂-ZnO the percentage of reflected beams in VIS region reduced considerably.

PAPER 11.6 — 11:05

CHARACTERIZATION OF CATALYTIC CERAMIC COATINGS PRODUCED BY ELECTROLYTIC DEPOSITION.

S.N. ASHRAFIZADEH, B. BARZEGAR, Department of Chemical Engineering, Iran University of Science and Technology, Tehran, Iran, and

F. ASHRAFIZADEH, Iranian Surface Research and Engineering Center (ISREC), Isfahan, Iran

Surface and interface properties of ceramic coatings based on titanium and ruthenium oxides have been evaluated on titanium substrates. The latter coatings which exhibit catalytic performance in the chemical and electrochemical reactions, were produced by ELD; an electrolytic deposition of ionic species. Process parameters were optimized in terms of thickness uniformity, coating adhesion, and the ratio of oxides formed on the surface. Phase identification was carried out by X-ray diffraction technique and the morphology of the coatings was studied by scanning electron microscopy. Experimental results indicate good correlation between deposition parameters and final properties of coated titanium. A cracked columnar TiO₂ coating with proper adhesion to the substrate can be achieved at moderate deposition rate; the adhesion decreased with increasing RuO₂ content or at higher thickness.

PAPER 11.7 — 11:30

EVALUATION OF MAGNETIC PROPERTIES OF WC-10Co HARDMETALS CONTAINING CARBIDE ADDITIVES FOR QUALITY CONTROL PURPOSES.

P. ABACHI and K. PURAZRANG, Department of Materials Science and Engineering, Sharif University of Technology, Tehran, Iran

In recent years, the interest in improved mechanical properties, high-surface finish, and long life time requirements of hard metals dictated provision of fine grain microstructure. Because there is no easy, widely agreed available non-destructive method for measuring grain size, magnetic properties measurements could be considered as the most important and empirically non-destructive quality test. Because of dependence of coercive strength as a magnetic property on many complex and interactive parameters such as grain size, cobalt content, and carbon deficiency, it is better to use it as a quality control factor rather than to determine absolute values of such parameters. In this study, VC was used in conjunction with (Ta, Nb)C as grain refiner. These materials are added in the form of carbide to the WC and Co powder blend, which was always the same, in a total amount of 3 wt%. The test specimens were prepared by the usual powder metallurgical route, i.e., milling, granulation, pressing and liquid phase sintering at two different temperatures, 1420°C and 1480°C. It was attempted to provide the same processing conditions, so that the resulting differences in magnetic properties and microstructure were due to variations in sintering temperature, which has direct effect on grain size, or amount of additives. The magnetic properties were determined as per the ISO 3326 standard. Furthermore, the optical microscopy examinations were performed on sintered specimens to compare predicted magnetic test results with microstructure of samples. According to test results, decreasing sintering temperature and increment of VC additive content enhanced coercive strength, H_c, but had no considerable effect on magnetic saturation, M_s. Moreover, the optical microscopy examinations of straight WC-10Co samples indicated on the finer prismatic shape of carbide grains in sintered samples at lower temperature. In samples containing additives as grain growth inhibitors, the percentage of WC was decreased and the portion of cubic carbides increased. This effect enhanced by increasing VC as the most effective grain-refining additive. These evaluations revealed an acceptable coincide between microstructure and predictions resulted from magnetic properties measurements on investigated hard metals. This means coercivity provide an indirect method for estimating grain size. It is also recommended that the magnetic saturation must be taken into account to correctly predict the grain size of samples with varying carbon content or different sorts of additives.

SESSION 12: SECOND INTERNATIONAL SYMPOSIUM ON ECOMATERIALS AND ECOPROCESSES

GREEN MATERIALS PROCESSING TECHNOLOGIES

Sponsor: Materials Science and Engineering Section, The Metallurgical Society of CIM

Room: Beluga

Chairman: R.A.L. DREW, Department of Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

PAPER 12.1 — 8:30

SENSORS FOR METALS PROCESSING/RECYCLING — AN OVERVIEW.

A. AHMAD, Materials Technology Laboratory, Natural Resources Canada, Ottawa, Ontario, Canada

The refining step in both primary and secondary metals processing requires the monitoring and control of impurities in molten metal for improved product quality. The detection and subsequent removal of these impurities is particularly more challenging in secondary metals processing/recycling which utilizes scrap metal, providing a more complex molten metal solution. High-temperature chemical sensors offer the potential for the on-line monitoring of these impurities during molten metal processing. The use of these chemical sensors for in situ/on-line detection of impurities during both primary and secondary metals processing can lead to a reduction in production time, improved product quality, lower production costs, and minimize energy consumption with commensurate reduction in greenhouse gas (GHG) emissions. This paper provides a brief overview of the basic operating principles and the required characteristics of the chemical sensors for the detection of impurities in molten metal. Examples are provided on the use of chemical sensors for both primary and secondary metal production. Some of the gaps in chemical sensor technology, particularly for use in the secondary metals processing (recycling) area have also been identified. Continued R&D efforts are needed to overcome these technological challenges in order to make the metal production/recycling process more efficient.

PAPER 12.2 — 8:55

NOVEL CAPILLARY GAS SENSOR FOR HYDROGEN AND HYDROCARBONS.

F. HOSSEIN-BABAEI, Canadian High Temperature Research Ltd., Vancouver, British Columbia, Canada,

M. ORVATINIA and T. TROCZYNSKI, Metals and Materials Engineering Department, The University of British Columbia, Vancouver, British Columbia, Canada

A simple, low-cost sensor for mixed gas diagnosis, consisting of a semiconductor gas sensor and a series of capillary tubes for gas components re-separation, is proposed. The key feature of this Capillary Gas Sensor (CGS) is that the target mixed gas diffuses through the tube before affecting the sensor. The retardation of gas transport, different for each component of the gas (i.e., characteristic for molecular size of the gas) determines the transient response of the device. Response of the sensor relates to the nature and concentration of the target gas components, effectively resulting a fast diagnosis of the gas mixture. All the components of the sensor are currently available off-shelf, low-cost products, which are re-assembled into a new product according to the present invention. It is demonstrated, through theory, experiment, and performance of the prototype device, that this new concept works well for variety of gases, and in particular for hydrogen and various hydrocarbons.

PAPER 12.3 — 9:20

COMBUSTION GAS ANALYSIS USING CHEMICALLY PROCESSED SnO_2 -BASED SEMI-CONDUCTING GAS SENSORS.

A. AHMAD and J. WALSH, Materials Technology Laboratory, Natural Resources Canada, Ottawa, Ontario, Canada

Three different chemical processing routes have been used to synthesize tin oxide-based precursor powders. Thick-film screen-printing technology was used to fabricate gas sensors using these precursor powders. The influence of powder processing and sensor fabrication conditions on the detection of combustion gases (e.g., methane, propane, carbon monoxide, ethanol) and various other physical properties of the materials were investigated. Sensors were also fabricated using tin oxide powders obtained from a commercial source and their gas sensing and physical characteristics were investigated. The results indicate that the powder processing methodology and the sensor fabrication conditions substantially influence the physical characteristics as well as the gas sensing properties of the sensors.

PAPER 12.4 — 9:45

CO_2 SEPARATION FROM COMBUSTION FLUE GAS.

S. WONG, H. YUAN, J. ZHOU, Alberta Research Council, Edmonton, Alberta, Canada, and

X. FENG, University of Waterloo, Waterloo, Ontario, Canada

CO_2 recovery from combustion flue gas offers the prospect of supplying large quantities of CO_2 for enhanced oil recovery and enhanced coalbed methane applications. For post-combustion CO_2 separation, there are four approaches, namely: liquid absorption (chemical and physical absorption), solid physical adsorption (pressure swing and temperature swing adsorption), membrane separation, and cryogenic separation. This paper will assess the suitability of these methods and using data in the literature, evaluate the economics of a number of these technologies and how the economics might be improved in the near to medium term.

COFFEE BREAK — 10:10 – 10:40

PAPER 12.5 — 10:40

HYDROGEN GENERATION THROUGH ALUMINUM-ASSISTED WATER SPLIT REACTION.

A.C.D. CHAKLADER, T. TROCZYNSKI, V. BAPOOJI and V. CHASKAR, Department of Metals and Materials Engineering, The University of British Columbia, Vancouver, British Columbia, Canada

The method of generation of hydrogen gas from water using chemical reactions is not new or original, e.g., there is several well-known systems under investigation and commercial development (including sodium borohydrate or other sodium compounds). The novelty of the proposed technology is that it uses aluminum at neutral (pH = 7) or close to neutral conditions, thus making it environmentally friendly and completely recyclable. The key discovery made by Dr. Chaklader is that passivation of Al in contact with some oxides, in particular aluminum oxide, can be prevented even in neutral conditions in pure water. Thus, the "corrosion" reaction proceeds spontaneously, with formation of hydrogen and aluminum hydroxide. This process can be used for generation of hydrogen-on-demand, e.g., to supply on-board fuel cell, without a need for pressurized container. It will be demonstrated that in the Al-Al₂O₃ system with 30 wt% of Al₂O₃ (both and), about 1 L of H₂ can be generated out of 1 g of Al. The effects of temperature, concentration of the oxide phase, particle size of Al, and pH of water was studied for the system, Al-Al₂O₃, and will be presented in details.

PAPER 12.6 — 11:05

HYDROTHERMAL SYNTHESIS OF POTASSIUM-TYPE ZEOLITE FROM COAL FLY ASH AND ITS PHYSICAL PROPERTIES.

N. MURAYAMA, M. TANABE, S. YOSHIDA, H. YAMAMOTO and J. SHIBATA, Department of Chemical Engineering, Kansai University, Osaka, Japan

The hydrothermal synthesis of potassium chabazite (K-CHA), which is one of the zeolitic materials, was carried out by using coal fly ash as a raw material. The production of zeolitic materials was one of the effective uses of coal ash. Various physical properties such as chemical composition, crystal structure, cation exchange property, acid resistance, and heat resistance were investigated for the obtained K-CHA product. K-CHA is obtained in KOH or K₂CO₃ solutions by a hydrothermal reaction at 393 K. The production of K-CHA is confirmed to begin at the reaction time of 5 h, and then the crystallization degree of K-CHA becomes constant at about 10 h. The value of cation exchange capacity (CEC) of the product is about 250 meq/100 g at the reaction time of 50 h, at which crystallization degree reaches a saturation state. Median diameter of the obtained K-CHA is about 20 Mm. The K-CHA consists of unreacted coal fly ash or fine coagulated particles of K-CHA as a nuclear. The crystallization degree of the K-CHA decreases with a decrease in pH, and K-CHA crystals are dissolved in pH below 4. In the heat treatment at 1273 K, K-CHA structure changes into leucite, potassium aluminosilicate. The K-CHA contains about 10% water and about 3% unburned carbon.

PAPER 12.7 — 11:30

HEAT PIPE COOLING OF COPPER BLOCK TAPHOLES.

P. NAVARRA and F. MUCCIARDI, Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

Copper-block tapholes are used in many types of metallurgical furnaces and are typically water-cooled. There are three major disadvantages to such a system: first, the system is fundamentally unsafe, failure of the cooling channels in metallurgical operations is potentially catastrophic. Second, excessively large quantities of water are passed through the cooling channels in order to prevent vapour formation, leading to extensive and costly water-pumping infrastructure. Third, the heat energy extracted from the tapholes is so dilute that it cannot be recovered or recycled elsewhere in the plant. By retrofitting existing tapholes with heat pipes, the thermal energy from the tapholes can first be moved out of and away from the molten metal, and then be dissipated into a coolant fluid such as water. The successful implementation of heat pipe technology to the cooling of tapholes is shown to lead to a safer system which uses much less water and which can produce higher-grade energy that is suitable for subsequent processing.

PAPER 12.8 — 11:55

A NEW WATERLESS OXYGEN LANCE: THE THERMOPUMP LANCE.

Z. YUAN and F. MUCCIARDI, Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

The Thermopump Lance as developed at McGill University is based on heat pipe technology. It can be used in pyrometallurgical processes that require the injection of oxygen into a melt. Typically, the nozzle region of an oxygen lance that is used to refine steel in an electric arc furnace (EAF) is the most difficult location to cool. With current practice, the entire lance body including the nozzle region is cooled by a low temperature, high-velocity water flow, which not only requires a sizable infrastructure for handling the water but it also raises some serious safety concerns. Moreover, the energy that is removed by the cooling water cannot be recovered. Thus, replacing the classical water-cooled lance with the new heat pipe-based lance, Thermopump Lance; which is now nearing commercialization, can help solve some of the problems. The key feature of the lance is its super conductivity of heat energy; about 1000 times that of copper. This makes the temperature of the whole lance almost uniform during its operation. Thus, the oxygen reagent can be used to cool the lance as it is injected. This represents a dramatic improvement in energy efficiency and safety. Moreover, there is a substantial reduction in infrastructure and operating costs. In addition, this lance can increase productivity since it can be positioned closer to the melt surface and thus can increase the stirring of the steel. The paper describes the evolution of the Thermopump Lance; to its current configuration. Some theoretical analysis of the unit is also presented.

TUESDAY, AUGUST 26, 2003, P.M.

SESSION 22: SECOND INTERNATIONAL SYMPOSIUM ON ECOMATERIALS AND ECOPROCESSES

MATERIALS LIFE CYCLE ANALYSIS

Sponsor: Materials Science and Engineering, The Metallurgical Society of CIM

Room: Orca

Chairman: J.A. KOZINSKI, Department of Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

PAPER 22.1 — 14:00

APPLICATION OF LIFE CYCLE ASSESSMENT FOR Pb-FREE BRASS.

N.T. ROCHMAN, Japan Science and Technology Corporation, Kagoshima Prefectural Institute of Industrial Technology, Kagoshima, Japan,

A. NAKANO, S. SUEHIRO, K. YAMADA, Department of Mechanical Engineering, Kagoshima University, Kagoshima, Japan,

K. HAMAISHI, Kagoshima Prefectural Institute of Industrial Technology, Kagoshima, Japan, and

H. SUEYOSHI, Department of Nano Structured and Advanced Materials, Graduate School of Science and Engineering, Kagoshima University, Kagoshima, Japan

Because of the adverse toxicity of Pb, Pb-free brass has been developed conscientiously. There are two ways to attain Pb-free brass: by using virgin materials and using scrap brass after removing the Pb content. In the present study, a technology has been developed to remove Pb from brass. In order to know the environmental effects, life cycle assessment (LCA) has been applied on Pb-free brass. The results show that by using the technology developed in the present study for removing Pb from scrap brass, resource consumption and CO₂ emission could significantly decrease.

PAPER 22.2 — 14:25

Pb-LESS BRASS WITH HIGH DEZINCIFICATION IN LCA PERSPECTIVE.

N.T. ROCHMAN, Japan Science and Technology Corporation, Kagoshima Prefectural Institute of Industrial Technology, Kagoshima, Japan,

A. NAKANO, S. SUEHIRO, K. YAMADA, Department of Mechanical Engineering, Kagoshima University, Kagoshima, Japan,

K. HAMAISHI, Kagoshima Prefectural Institute of Industrial Technology, Kagoshima, Japan, and

H. SUEYOSHI, Department of Nano Structured and Advanced Materials, Kagoshima University, Kagoshima, Japan

Recently, environmental problem has become a significant issue. Particularly in water supplies, the public demand for using Pb-free brass with high dezincification resistance is increasing. A new technique for removing Pb from brass as an alternative to recycle scrap brass containing Pb in life cycle assessment (LCA) perspective has been developed. Brass containing 2.15% mass Pb were melted at 930 °C and calcium-silicon compound was added into the molten brass so that it reacted with Pb to form Ca-Pb-Si-like compound. This Ca-Pb-Si-like compound was then taken out from the molten brass. In order to increase dezincification resistance, alloying element, P, was added into the molten brass. After casting into a metal mould, the ingot was annealed at 550 °C for 0.5 h. The specimen from the ingot was characterized by EMPA, fluorescence X-ray analysis. Dezincification test was carried out by using a galvanostatic anodic polarization. The results show that Pb content decreases significantly up to 53% and dezincification resistance increases considerably.

PAPER 22.3 — 14:50

LIFE CYCLE IMPACT ASSESSMENT FOR LEAD-FREE SOLDER — CONSIDERING THE POTENTIAL DAMAGES TO HUMAN SOCIETY.

N. ITSUBO, J. NOH and A. INABA, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan

The concern with lead-free solder has been growing to the point of avoidance of exposure from lead, but the effect on other environmental problems, such as global warming generated from the increasing energy consumption for producing lead-free solder, has also been pointed out. In order to consider this trade-off relationship, life-cycle impact assessment for lead-free solder was examined with a comparison to conventional solder in this study. Damage-oriented life-cycle impact assessment methodology developed by the authors were applied for this study. Potential damage on human health caused by the production of lead-free solder was estimated higher than that caused by the production of Pb solder. On the other hand, potential damage to social welfare for the production of lead-free solder was estimated lower than that for the production of Pb solder.

COFFEE BREAK — 15:15 – 15:45

PAPER 22.4 — 15:45

SUSTAINABLE DEVELOPMENT OF COALBED METHANE — A LIFE-CYCLE APPROACH TO PRODUCTION OF FOSSIL ENERGY.

W.D. GUNTER, S. WONG, D. H.-S. LAW and Z. ZHOU, Alberta Research Council, Edmonton, Alberta, Canada

Alberta Research Council (ARC) is leading an international program in CO₂ enhanced coal bed methane (ECBM) production. The main objectives of this project are to develop technologies to reduce greenhouse gas (GHG) emissions by subsurface injection of carbon dioxide (CO₂) into deep coalbed and to enhance coalbed methane (CBM) recovery factors and production rates as a result of carbon dioxide injection. With broad industry and government participation, the project conducts laboratory experiments, numerical simulation, pilot testing, and economic evaluations of CO₂-ECBM. Issues related to materials in handling various streams of CO₂ gas will be discussed.

PAPER 22.5 — 16:10

LIFE CYCLE STUDY OF GASIFICATION OF MUNICIPAL SOLID WASTE.

A. HALOG, M. SAGISAKA and A. INABA, LCA Research Center, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan

Communities throughout the world are struggling to develop more efficient and cost-effective municipal waste management systems. In the past, waste management systems comprised waste collection and disposal at a local landfill. Due to decreasing landfill sites and growing waste volume, the community demands that waste management should account for its cost, resource recovery and its environmental consequences. With consideration to data variability and uncertainty, an LCA study of municipal solid waste gasification plant in Ibaraki area, Japan is conducted. The data uncertainty is addressed with the use of probability distributions, Monte Carlo Simulation, and importance analysis. Eventually, final LCA outcomes are interpreted.

PAPER 22.6 — 16:35

CASE STUDY FOR CALCULATION OF FACTOR X — COMPARING CRT TV, LCD TV, AND PDP TV.

T. AOE, Corporate Environmental Affairs Division, Matsushita Electric Industrial Co. Ltd., Osaka, Japan

In general, LCD TV sets are considered more environmental-friendly than CRT TV sets and PDP TV sets. However, this perception is based only on energy consumption during use. Judgment should be assessed not by focussing only on one stage but on the entire product life cycle from materials manufacture to product disposal including auxiliary materials, material yield loss, production yield loss, etc. Furthermore, it should also be assessed from viewpoints of not only energy but also resources and the toxicity. A Factor X (eco-efficiency) tool was independently developed from those viewpoints in 2001 and introduced to Matsushita Electric Group. Case studies have already been published. This tool has three critical concerns: the prevention of global warming (save energy); the effective utilization of resources, and the use of non-toxic materials. Three types of TV set will be assessed by using this tool. The environmental impact will be assessed from the viewpoints of not just one life cycle stage but considering the entire life cycle. Furthermore, impacts will be assessed considering not only the prevention of global warming (save energy) but also three critical concerns described above. Product function reflecting each product feature would be also be considered. Finally, this paper will propose the appropriate use of TV sets and will study also about the validity of this tool.

PAPER 22.7 — 17:00

A LCI STUDY ON A CLOSED LOOP POST CONSUMER PET BOTTLE RECYCLING PROCESS.

S. INADA, T. SUGIMOTO and T. TAKAI, AIES Co. Ltd., Tokyo, Japan

A LCI study was done on a feedstock recycling process of post-consumer (PC) PET bottles called AIES Process. AIES process established a closed loop recycling of PET resin for food contact use by obtaining high-purity BHET [bis-2(hydroxyethyl) terephthalate], the monomer, without dissolving itself down to raw materials of PET such as terephthalic acid, dimethyl terephthalate, and ethylene glycol. Actual engineering data of AIES process commercial plant of AIES process are employed for the study. The study proved energy consumption for out-putting recycled resin requires only half of the energy that virgin resin production requires if FSE (feed stock energy) is used.

WEDNESDAY, AUGUST 27, 2003, A.M.

SESSION 33: SECOND INTERNATIONAL SYMPOSIUM ON ECOMATERIALS AND ECOPROCESSES

TECHNOLOGIES FOR REMEDIATION OF GREENHOUSE GASES

Sponsor: Materials Science and Engineering, The Metallurgical Society of CIM

Room: Orca

Chairman: A. AHMAD, Materials Technology Laboratory, Natural Resources Canada, Ottawa, Ontario, Canada

PAPER 33.1 — 8:30

APPLICATION OF BIOMASS AS A REMEDY FOR GHG EMISSIONS.

F. ELDABBAGH, E. ROSEN, J. HAWARI, J.-P. FARANT, W. HUTNY, M. GROVES and J.A. KOZINSKI,

Department of Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

Biomass is considered by many as “the fuel of the future.” Indeed, this renewable energy source is nearly CO₂ neutral, which implies a 93% reduction in net CO₂ emissions achieved by switching from coal to biomass and an 84% reduction by switching from natural gas-fired cogeneration. However, detailed mechanisms involved in the evolution of biomass during combustion are still unknown. This paper discusses new knowledge of the behaviour of biomass during combustion. It provides new data on the fundamental mechanisms responsible for biomass conversion, polycyclic aromatic compounds formation/destruction, and rearrangement of metals, while showing advantages toward GHG emissions. A new technology for generation of clean biomass energy in which the environmental impact of combustion are significantly reduced and biomass combustion optimized is described. Tomorrow’s biomass power industry in Canada could install, by 2020, as many as 25 000 MW of electric power plants operating on reliable and renewable biomass. This would support almost 180 000 jobs, an increase of 130 000 from the current 50 000, and would substantially revitalize rural economies (e.g., farmers in Saskatchewan could designate parts of the land for energy crops, which could help solve some of their ongoing problems). Such industry would generate reliable base-load electric power without contributing to climate change. Thus, the major incentives for the use of biomass for energy generation are both economical and environmental.

PAPER 33.2 — 8:55

CEMSTAR PROCESS AND TECHNOLOGY FOR LOWERING GREENHOUSE GASES AND OTHER EMISSIONS WHILE INCREASING CEMENT PRODUCTION.

D. PERKINS, TXI, Dallas, Texas, U.S.A.,

J.R. YATES and R. SANKARANARAYANAN, HATCH, Toronto, Ontario, Canada

It has been estimated that the cement industry contributes about 7% of the world’s CO₂ emissions. CemStar[™] is a patented process developed and implemented by Texas Industries, Inc. (TXI) in a number of cement kilns in the United States. The CemStar process has been proven to significantly reduce CO₂ as well as NO_x emissions, while at the same time reducing energy and refractory consumption, and increasing cement clinker production. A low-value steel industry waste or by-product (steelmaking slag) is charged directly into the kiln in the CemStar process. Actual data from several US cement plants will be presented, along with a discussion of various additional benefits to cement plant operation (including reduced costs and improved kiln stability).

PAPER 33.3 — 9:20

THE FREEDOMCAR PARTNERSHIP.

J.A. CARPENTER, Jr., U.S. Department of Energy, Washington, District of Columbia, U.S.A.

One striking feature of the U.S. transportation system is its nearly complete dependence on petroleum as an energy source. Petroleum is used to satisfy 95% of America’s transportation energy needs, consuming two-thirds of all the petroleum used. Since roughly 55% of petroleum is imported from abroad, the implications of this dependency on U.S. energy security are readily apparent. Therefore, the U.S. Department of Energy (DOE) and the U.S. Council for Automotive Research (USCAR) announced in January 2002 a new cooperative research effort known as the FreedomCAR Partnership to fund high-risk, high-payoff research into advanced automotive technologies with the potential for dramatically lowering this dependence. The new partnership replaces and builds upon the Partnership for a New Generation of Vehicles (PNGV) initiative that ran from 1993-2001. The long-term transition of vehicles from gasoline to hydrogen is viewed as critical in lowering the dependence of the U.S. economy on foreign oil, and in reducing the environmental impact of the personal transportation sector. In addition to the longer-term work on fuel cells and hydrogen infrastructure, the FreedomCAR Partnership conducts research on technologies with the potential for shorter-term energy efficiency and environmental benefits, such as new engine concepts, lightweight materials, and hybrid propulsion components. The goals of current FreedomCAR technology research are:

- Develop reliable systems for future fuel cell powertrains with costs and performance comparable to conventional internal combustion engine/automatic transmission systems.
- Enable clean, energy-efficient vehicles operating on clean, hydrocarbon-based fuels powered by either internal combustion powertrains or fuel cells.
- Enable reliable hybrid electric vehicles that are durable and affordable.
- Enable the transition to a hydrogen economy, ensure widespread availability of hydrogen fuels while retaining the functional characteristics of current vehicles.
- Develop material manufacturing technologies for light-weight, high-volume production vehicles.
- The long-term results of this cooperative effort will be cars and trucks that are more efficient, cheaper to operate, pollution-free and competitive in the showroom.

PAPER 33.4 — 9:45

HIGHLY EFFICIENT RESIDENTIAL SOLAR HOUSING.

K. SZYMOCHA, Alberta Research Council, Edmonton, Alberta, Canada

With the start of the new century, trends are emerging that will affect residential houses design and construction. The most important being improved thermal insulation (reduced heat losses) low energy consumption, low costs and application of the recycled materials. Very important factor is reduction of the related to the house construction and operation CO₂ emissions by using new materials, advanced technologies and renewable sources of energy. One of the most promising options is application of the advanced solar energy systems used for electricity and heat generation. The most promising and realistic solutions to achieve this is the development of a residential houses that are equipped with their own solar-based energy generating system combined with an energy storage and reliable backup system. Using more sophisticated designs a zero net energy houses construction in the cold climate regions like Canada is possible.

COFFEE BREAK — 10:10 – 10:40

PAPER 33.5 — 10:40

MICRO SOLID OXIDE FUEL CELL.

P. SARKAR and H. RHO, Ceramic Engineering Group, Advanced Materials Business Unit, Alberta Research Council, Edmonton, Alberta, Canada

The Alberta Research Council Inc. (ARC) is developing Tubular Micro Solid Oxide Fuel Cell (SOFC). Small diameter SOFC has two main potential advantages, substantial increase in the electrolyte surface area per unit volume of a stack and quick start-up. Since fuel cell power is directly proportional to the electrolyte surface area, a SOFC stack has high potential to substantially increase the power per unit volume. Simple calculation shows a decrease of tube diameter from 22 mm to 2 mm will increase the electrolyte surface area in a stack at least seven times. Due to its thin wall, a SOFC has extremely high thermal shock resistance and low thermal mass. These low thermal mass and high thermal shock resistance characteristics are fundamental to reducing start-up and turn-off time for the SOFC system. This paper will describe fabrication, microstructure and electrochemical characteristics of SOFC.

PAPER 33.6 — 11:05

PROSPECTS OF BIOMASS AS SOURCE OF FUEL CELLS.

F. GIRARD and F. MORAW, NRC Innovation Centre, Vancouver, British Columbia, Canada

Biomass could play an important role as a source of fuel in the future allowing efficient waste management as well. In addition the use of fuel cell technology would potentially make efficient use of the energy extractable from this source impacting positively the emission of greenhouse gases from fossil fuels. Various paths will be explored and an example of the application of biomass conversion and fuel cell technologies in the pulp and paper industry and its impacts will be presented.

PAPER 33.7 — 11:30

PROCESS ENGINEERING OF SOL-GEL CERAMIC COMPOSITE COATINGS FOR FUEL CELL SYSTEMS.

G. LI, J. FU, H. KIM, M. CHEN, M. BURSA, Q. YANG and T. TROCZYNSKI, Metals and Materials Engineering Department, The University of British Columbia, Vancouver, British Columbia, Canada

The novel technology of chemically bonded composite sol-gel (CB-CSG) coatings has been developed at UBCeram. This essentially “ceramic paint” technology operates with CSG slurries formulated to contain a sol-gel “glue,” e.g., hydrated alumina sol, and inert filler, e.g., alpha alumina or zirconia, suspended in water or other solvent. The CSG is spray-deposited on metallic surfaces, and heat-treated at about 300 °C to partially dehydrate the gel-derived hydroxides. CSG film is subsequently chemically bonded (CB) through reaction of the gel-derived active alumina with metal phosphates, such as aluminum phosphate. To address the issue of coatings porosity, a novel chromate-free process is under development to provide protective coatings for metals, in particular for fuel cell heat exchangers. The process involves impregnation of monomeric MPS (methylphenylsiloxane) into the micropores of 20 to 40 μm thick CSG alumina coating, and polymerization of MPS to form impermeable inorganic polymer/ceramic composite. The coatings have been deposited on variety of metallic substrates to produce protective barriers against wet corrosion. The coatings chemistry and microstructure have been studied. The essential mechanical properties of the coatings have been evaluated. Corrosion protection abilities of the coatings have been determined as a function of coatings processing parameters. The progress in these and related areas of research at UBCeram will be reported.

PAPER 33.8 — 11:55

PROPERTIES OF SELECTED CERAMIC MATERIALS APPLIED IN HYDROGEN GENERATION SYSTEMS.

A. RAMESH, S. XU, D. FLETCHER, PrecisionH2 Inc., Montréal, Québec, Canada,

J.A. KOZINSKI and R.A.L. DREW, Department of Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

Under the Kyoto Protocol, Canada committed to reduce greenhouse gas (GHG) emissions by 6% from 1990 levels by the period 2008 to 2012. Most of the other industrialized countries of the world made similar commitments, although the exact percentage reduction varies from country to country. One of the cleanest energy sources currently available is hydrogen. If it was possible to generate H₂ without GHG emissions it would help meet the ambitious Kyoto targets. The focus of our research was on the GHG-free method of H₂ generation using high dielectric ceramics. Currently, most of the high dielectric ceramic materials being used as capacitors are based on barium titanate (BT). A maximum dielectric constant of 4500 (\pm 15%) and a dissipation factor of better than 2.5% within the temperature range of -55 C to 125 C can be achieved. Beyond 125 C, the permittivity falls off unacceptably at any applied field due to phase transition. At the present time, there is no commercially available high-temperature high-dielectric constant ceramic necessary for H₂ systems. However, there are two novel and very promising complexes: (1) CaCu₃Ti₄O₁₂ (CCTO) and (2) Bi_{10.5}Na_{0.5}TiO₃ - Me^(II)TiO₃ (BNT-Me^(II)T) where Me^(II) are group II metals. CCTO shows a dielectric constant at 1 kHz of about 12 000 between room temperature and 300 C. However, there are no data on the loss factor, mechanical stability and shock resistance of CCTO. Furthermore, there is no information available on its dielectric properties (permittivity, dielectric strength and leakage current) at high voltage fields. Establishment of these properties and verification of the overall material performance are emphasized in this project. In order to better understand the effects of microstructural features (grain size, and grain boundary phases/chemistry) on the dielectric properties of the selected high-temperature ceramics, a combination of SEM and microanalysis is used.

WEDNESDAY, AUGUST 27, 2003, P.M.

SESSION 44: SECOND INTERNATIONAL SYMPOSIUM ON ECOMATERIALS
AND ECOPROCESSES

DESIGN TECHNOLOGIES FOR MATERIALS RECYCLING AND REUSE

Sponsor: Materials Science and Engineering, The Metallurgical Society of CIM

Room: Orca

Chairman: M. CLAPHAM, Resource Recovery and Recycling, Natural Resources Canada, Ottawa, Ontario, Canada

PAPER 44.1 — 14:00

AUTOMOTIVE MATERIALS RECYCLING: A STATUS REPORT OF U.S. DOE AND INDUSTRY COLLABORATION.

E.J. DANIELS, Energy Systems Division, Argonne National Laboratory, Argonne, Illinois, U.S.A.

The objectives of this status report are: (1) to briefly outline the current status of automotive materials recycling, (2) to provide an overview of DOE/industry technology development to improve automotive materials recycling, to date, and (3) to outline the goals and objectives of DOE and industry's five-year automotive materials recycle research plan. Today, about 75% of automotive materials are profitably recycled via parts re-use (through the dismantling industry), parts and components remanufacturing (through the remanufacturing industry) and, ultimately by materials recovery (through the scrap processing industry). Working with industry, the U.S. DOE has supported the development of technology to increase the current level of automotive materials that are recycled. For example, a process for recovering and recycling flexible urethane foams, developed at Argonne National Laboratory, is presently undergoing commercial demonstration. The DOE has also supported development of technology to improve the efficiencies of both steel and aluminum recycling. As the complexity of automotive materials and systems increases, new technologies will be required to sustain and maximize the ultimate recycling of these materials and systems at end-of-life. To meet the challenges of automotive materials recycling, the DOE has recently expanded its collaborative research in this area. This paper discusses current and planned recycle R&D.

PAPER 44.2 — 14:25

SOLID STATE RECYCLING AS AN ENVIRONMENTAL BENIGN MANUFACTURING FOR LIGHTWEIGHT ALLOYS.

T. AIZAWA, Center for Collaborate Research, University of Tokyo, Tokyo, Japan,

T. LUANGVARANUNT, Graduate School of Engineering, University of Tokyo, Tokyo, Japan, and

K. KONDOH, Research Center for Advanced Science and Technology, University of Tokyo, Tokyo, Japan

A huge amount of energy is needed for melting/remelting and solidification of lightweight alloy scraps. In addition, dross and slug are inevitably ejected from the conventional recycling processes. Since these aluminum and magnesium alloys are easy to be oxidized or reacted, SF₆ or other gaseous hazardous components must be used even for recycling. Furthermore, the above recycled alloys have insufficient grade in mechanical properties, so that these materials cannot be used repetitively as the same product. Solid state recycling is proposed as a candidate for environmentally friendly manufacturing to overcome the above difficulties. In addition to the energy saving during the process, little or no hazardous components are ejected in this recycling. Due to the in-process refinement in microstructure, the mechanical properties can be promoted to nearly the same level for the virgin materials. Al-12 at%Si alloy is employed to quantitatively describe this up-grading in the present solid-state recycling.

PAPER 44.3 — 14:50

CARBON PRODUCTS FROM WASTE PRODUCTS – MANUFACTURING AND USE.

Y. SHINOGI, National Institute for Rural Engineering, Tsukuba, Ibaraki, Japan

Material circulation is one of the popular concepts these days. There are various kinds of recycling technologies, and the authors have been proposing "carbonization", as one of the eco-friendly technologies. Carbonization reduces their weight, volume, bad odour, and, finally, it enables waste products to be handled with ease. Also, it produces a relatively smaller amount of dioxin. Carbon products are reported as light, porous and have high adsorption, and therefore they can be utilized variously for soil dressing, absorbents, especially in agriculture, etc. This paper will report carbonization, its manufacturing technology and characteristics of the carbon products from waste products, mainly agricultural by-products.

COFFEE BREAK — 15:15 – 15:45

PAPER 44.4 — 15:45

MESO-SCOPIC DESIGN FOR BARRIER-FREE PROCESSING TOWARD UPGRADE RECYCLING.

T. AIZAWA and K. KONDOH, Center for Collaborate Research, University of Tokyo, Tokyo, Japan

The barrier-free processing, which has been developed by the priority research group in Japan, aims for improvement of mechanical properties through each recycling process. In order that the starting recyclable matters should have superior mechanical properties, their microstructure must be better controlled by new principles for upgrade recycling. In the present paper, the general schemes in the meso-scope materials design are first introduced to make in-process microstructure in the barrier-free processing. Construction of mass-loop for the magnesium alloys is employed as an example to demonstrate that high-grade magnesium alloy products can be fabricated in a solid state with reuse of silicon-wafer and silica wastes.

PAPER 44.5 — 16:10

SUCCESSFUL TREATMENT OF WASTES IN SUPERCRITICAL WATER.

A. SOBHY, Z. FANG, S. XU, J. HAWARI, J.-P. FARANT, W. HUTNY, C. COSCIA and J.A. KOZINSKI,

Department of Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

Water under supercritical conditions (374 °C, 22.1 MPa) behaves like a perfect organic solvent with acid-like characteristics. It can dissolve organics and hydrolyze polymers. During supercritical water (SCW) combustion no flame-generated pollutants are formed, emissions are reduced and heat generated. This paper described experimental results obtained from diamond anvil cell, batch reactor and continuous flow reactor where hazardous wastes were successfully treated applying SCW. Results concerning waste-to-product conversion, destruction efficiency and product characteristics are presented. Four types of organic materials (including industrial wastes) were studied: (1) pure benzo(a)pyrene (BaP) and benzo(b)fluoranthene (BbF); (2) contaminated industrial sludge; (3) styrene/butadiene-based rubber; and (4) polyethylene-based plastics. It is expected that users in the waste management sector from the automotive, steel, electrical and pulp and paper industries would be the major beneficiaries from the successful adaptation of the work discussed. The new understanding of the wastes evolution/destruction during supercritical water combustion and the technology in which pollutant formation is reduced could be implemented in various waste treatment facilities ranging from municipal to hazardous.

PAPER 44.6 — 16:35

A REVIEW ON THE RECOVERY OF GOLD BY THE THIOSULPHATE PROCESS.

E. ALFARO, D. MICHEL and J. FRENAY, Geomac-MTM, University of Liege, Liege, Belgium

The thiosulphate process is presently the best non-polluting alternative to the cyanide recovery of gold. A thermodynamical and electrochemical review of the chemical system Au-S-O-Cu, as well as the distribution and the (meta)stability of ionic species and polarographic experiments allow a better understanding of the mechanisms of the reactions. A phenomenological model is proposed. Important aspects such as catalytic role of Cu, consumption of reagent (which could be important due to the metastable character of thiosulphate), reagents concentration, kinetics aspects and the role of some protective agents such as amino acids or EDTA are emphasized. The recovery of gold from the pregnant solution can not be done by active carbon. The most promising processes are based on the use of ion-exchange resins. Details are given on the main parameters of that process.

PAPER 44.7 — 17:00

WASTE GASIFICATION AND SMELTING SYSTEM USING OXYGEN BLOWING BASED ON IRON-MAKING AND STEEL-MAKING TECHNOLOGIES.

T. YAMAMOTO, H. SATO, Y.M. MATSUKURA and Y. UJISAWA, Sumitomo Metal Industries Ltd., Ibaraki-Prefecture, Japan

The Sumitomo Metals gasification and smelting system, which is a new type of waste gasification and smelting system using iron-making and steel-making technologies based on high-temperature metallurgy, has been developed. This system can steadily gasify and melt not only municipal waste but also plastic waste, polyvinyl chloride (PVC) and auto shredded residue by using top blow lance together with sideways blow oxygen lances. As a result of gasification in the high-temperature reduction atmosphere and rapidly cooling, dioxin-free high calorie purified gas can be produced. Ash components in the wastes are smelted in a high temperature reduction atmosphere and the heavy metal-free high quality slag is produced. Most of chlorine in the wastes was recovered as crude hydrochloric acid. And conversion method into fine chlorine from the crude hydrochloric acid was studied for construction of economical chlorine recovery system. Furthermore, design of commercial plant will be conducted using a 3-dimensional mathematical simulation model that was developed by Sumitomo Metals.