

## PROCEEDINGS OF THE 58TH ANNUAL CONFERENCE OF METALLURGISTS (COM) HOSTING THE 10TH INTERNATIONAL COPPER CONFERENCE 2019

### Downstream Fabrication & Applications



576572

#### **Effect of Cold Working on Microstructure and Performance of CuCrZr Alloys**

Shiha Huang, Hang Wang, Huiming Chen, Weibin Xie, Bin Yang, and Wei Huang, Jiangxi University of Science and Technology



586728

#### **High Performance Cu-Ti Alloy Wires Prepared by Over-aging and Intense Cold-Drawing**

Satoshi Semboshi and Yusuke Kadoi, Institute for Materials Research, Tohoku University  
Yasuyuki Kaneno and Takayuki Takasugi, Department of Materials Science, Osaka Prefecture University  
Naoya Masahashi, Institute for Materials Research, Tohoku University



588607

#### **Fabrication of Porous Copper and Porous Copper Based Alloys with Controllable Pore Structure**

Shen Gong, Sangsang He, Yixuan Li, Zhou Li, and Lairong Xiao, Central South University



588753

#### **Microstructure, Physical and Mechanical Properties of Copper-Graphite Composites Fabricated by In-Situ Reaction Method**

Zhu Xiao, Rushi Chen, and Zhou Li, Central South University



588901

#### **Mechanical Behavior and Strengthening Mechanism of Discontinuous Precipitation in Cu-Ni-Mn Alloy**

Weibin Xie and Hang Wang, Jiangxi University of Science and Technology



589138

#### **Cu – Ni Concentration Gradient Alloy for Antimicrobial Efficacy Testing**

Hamed Akbari Khorami, The University of British Columbia  
Elizabeth Bryce, Division of Medical Microbiology and Infection Prevention, Vancouver Coastal Health and Department of Pathology and Laboratory Medicine, The University of British Columbia  
Titus Wong, VCHRI, Lions Gate Hospital, Vancouver General Hospital  
Richard Dixon, Coalition for Healthcare Acquired Infection Reduction  
Tysha Donnelly, VGH  
Edouard Asselin and Billie Velapatiño, The University of British Columbia



592319

#### **Interface and Bending Behavior of Cu/Al Composite Wires**

Zhen Yang, Haofeng Xie, Lijun Peng, Xue Feng, Guojie Huang, Xiangqian Yin, and Xujun Mi, GRIMAT Engineering Institute Co., Ltd.



594057

#### **The Simulation and Analysis on Die Casting Process of Copper Rotors**

Dong Liang, International Copper Association  
Jingyuan Bai, Ning Wang, and Renguo Guan, School of Materials Science and Engineering, Northeastern University of China  
Sheng Zhou, International Copper Association



594089

**Effect of Magnesium and Zirconium on Softening Behavior of Cr-Cr Alloy**

Lijun Peng, Haofeng Xie, Guojie Huang, Zhen Yang, Xue Feng, Xiangqian Yin, Dongmei Liu, and Xujun Mi, GRIMAT Engineering Institute Co., Ltd.



594545

**Aging Properties of Cu-0.93mass%Ni-0.24mass%P Alloy Tube**

Wataru Inagaki and Tetsuya Ando, Muroran Institute of Technology  
Kozo Kawano, UACJ Corporation

## Electrowinning & Electrorefining



577350

**History of Electrolytic Copper Refining in Japan - From the First Copper Refinery Up to the Present Day**

Susumu Okabe, The Mining and Material Processing Institute of Japan  
Phillip Mackey, P.J. Mackey Technology Inc.



581092

**Copper Electrowinning: 2018 Global Survey of Tankhouse Operating Practice and Performance**

Kathryn C. Sole, Kathryn C. Sole Consulting  
Michael S. Moats, Missouri University of Science and Technology  
Scot Sandoval, Freeport-McMoRan Mining Company  
Tim Robinson, Outotec  
William G. Davenport, University of Arizona



581429

**Reducing Ferric Ions in Acidic Electrolytes by Copper Powder Generated during Reactive Electrodialysis**

Ibáñez Juan Patricio, Universidad Técnica Federico Santa María  
Cortés Stefany, Minera Tres Valles SpA  
Ipinza Jorge and Casas Jesús, Universidad Técnica Federico Santa María



582049

**One Hundred Years of Electrolytic Copper Production in Finland**

Jari J. Aromaa, Olof Forsén, and Mari Lundström, Aalto University  
Petri Latostenmaa, Boliden Harjavalta



582991

**Technological Advances in the Electrolytic Cell**

Robert P. Dufresne, Pultrusion technique Inc.



587436

**The First Electrolytic Copper Refinery in Australia at Wallaroo, South Australia**

Phillip Mackey, P.J. Mackey Technology Inc.  
Ben McHenry, South Australian Museum  
Michael Reed, WorleyParsons  
Jon Weir, Inception Group  
Albert Wraith, Private Consultant



587553

**Copper Refining Electrolyte Purification Using Molecular Recognition Technology for Bismuth Removal- the Experience at Birla Copper**

Neil Izatt, IBC Advanced Technologies, Inc.  
Raghavendra Adiga, Birla Copper  
Steven Izatt, Ronald Bruening, Reed Izatt, and Luis Navarro, IBC Advanced Technologies, Inc.



588113

**The First Electrolytic Copper Refinery in the USA at the Chemical Copper Company, Phoenixville PA - History Revisited**

William Culver, State University of New York at Plattsburg  
Phillip Mackey, P.J. Mackey Technology Inc.  
Bradford Westrom, El Paso Refinery, Freeport-McMoRan  
Albert Wraith, Private Consultant



588813

**Solution Purification of Copper Electrorefining Electrolyte - A Novel Way to Recover Precious Metals**

Mari Lundström, Pyry-Mikko Hannula, Kirsi Yliniemi, and Benjamin Wilson, Aalto University  
Violeta Barranco, CSIC/ National Centre for Metallurgical Research CENIM  
Dawid Janas, Silesian University of Technology  
Annick Hubin, Vrije Universiteit Brussel



590965

**'Permanent' Cathode Plate - Consumable or Fixed Asset?**

Addin Pranowo, Nigel Aslin, Graham Heferen, and Ola Eriksson, Glencore Technology



591287

**Laboratory Scale Extraction of Bismuth and Antimony from a Copper Electrorefining Electrolyte Using a Proprietary Phosphonic Acid Ester Extractant**

Andrew J. Artzer and Michael S. Moats, Missouri University of Science and Technology  
Jack T. Bender, BASF



591294

**Arsine Risk Management at CCR's Electrolyte Purification Plant**

Billy Serviere, Hans Persson, and Arun Majumdar, Glencore Copper Canada - CCR Refinery



591456

**Applications of Lateralvex® and Lateralflow® Technologies in Minera Antucoya, (AMSA), EW Tank-house in Chile for Controlling Acid Mist and Retain Organic Entrainments in Commercial and Scavenger Cells**

Fernando J. Penna and Rodrigo A. Villarroel, Asesorias y Servicios Composites SpA  
Cristián Villaseca, Universidad Católica de Chile



592548

**Utilizing Ion Exchange for Impurity Control in Copper Electrolyte**

Katerina Kryst and Karem Elkayar, Eco-Tec Inc.



592622

**Advancements in Commercialization of De Nora's "Self-Protected Anode - SPA" for Metal Electrowinning**

Paolo Perrone, Luciano Iacopetti, Michele Perego, Alice Calderara, and Takashi Furusawa, De Nora Permelec Ltd.



592998

**Recent Operational Improvements at Saganoseki Electrorefinery**

Atsuki Sado, Akira Ueno, Kunio Watanabe, and Kazuaki Takebayashi, Pan Pacific Copper Co., Ltd.



593000

**Effect of Antimony, Nickel and Sulfuric Acid in Copper Electrorefining**


Daisuke Tetsuka and Hidenori Okamoto, JX Nippon Mining Metals Corporation



593955

**Recent Improvements at Tamano Refinery**

Soichiro Nakayama, Masakazu Fujihara, Makoto Narita, and Yasukatsu Sasaki, Hibi Kyodo Smelting Co., Ltd.

-  **593974**  
**Total Acid Mist Quantification within a Full-Scale Copper Electrowinning Cell**  
Krishna Mohanarangam and William Yang, CSIRO Mineral Resources  
Rueben Rajasingam, Australian Minerals Research Centre  
Bogale Tadesse, Curtin University  
Dave Robinson, Neometals Ltd.
-  **594034**  
**The Effect of Impurities on a Copper Starter Sheet Electrowinning Operation**  
Karen Voogt and Johann HWM. Brits, Anglo American  
Max Pelser and Helgard J. Gous, Anglo American Platinum
-  **594055**  
**The Latest Advancements in Cathode Stripping Machine Technology**  
Martti Larinkari, Max Schmidt, and Peter Nord, Outotec
-  **594275**  
**Monitoring Surface Roughness of Copper Electrodeposits Using Scaling Analysis**  
Jeffrey L. Shepherd, Jayde Keough, and Eduard Guerra, Laurentian University
-  **594301**  
**Settling Properties of Copper Electrorefining Anode Slimes**  
Taina Kalliomäki, Arif T. Aji, Jari J. Aromaa, and Mari Lundström, Aalto University
-  **594763**  
**Utilizing an Injection Molding Process to Create Edging for Starter Sheet Blanks Used in a Conventional Tankhouse**  
Tracy T. Morris, ASARCO LLC  
Weldon Read, Retired  
Rick Steen, Rhino Linings Amarillo South
-  **594788**  
**Investigation of Permascand Coated Titanium Anodes in Copper Electrowinning at Glencore Nikkelverk**  
Dr. Susanne Holmin, Permascand AB  
Torjus Åkre, Glencore Nikkelverk AS  
Åsa Afvander and John Gustavsson, Permascand AB  
Ernst Rosseland, Glencore Nikkelverk AS  
Erik Zimmerman, Permascand AB
-  **594797**  
**Electrolytic Refining of High Ni Copper Anode at the Tank House in Naoshima Smelter and Refinery**  
Takashi Ikemoto, Takashi Yamashita, and Osamu Inoue, Mitsubishi Materials Corporation
-  **594828**  
**Electrorefining of Low Grade Copper Alloys in Sulfamic Acid Media**  
Hidehiro Sekimoto and Tomohiro Sugawara, Iwate University
-  **594865**  
**Copper Electrowinning Developments at Glencore Nikkelverk**  
Torjus Åkre and Ernst Rosseland, Glencore Nikkelverk AS
-  **594884**  
**Root-cause Analysis of Lacy Copper Phenomena**  
Ana Rodriguez, Almansa and Francisco Jimenez, Atlantic Copper S.L.U.  
Guillermo Ríos and Rafael Ramírez Villalobo, Atlantic Copper  
Nigel Aslin, Glencore Technology



594940

**Global Survey of Copper Electrorefining: 2019 World Tankhouse Operating Data**

Michael S. Moats, Missouri University of Science and Technology  
Andreas Filzwieser, Mettop GmbH  
Shijie Wang, Rio Tinto  
William G. Davenport, University of Arizona  
Tim Robinson, Outotec  
Andreas Siegmund, LanMetCon



594965

**Reduction of Silver Loss in Copper Cathode**

Bhavin Desai, Lakshmi Kanth Reddy Madikunta, Vilas Tathavadkar, Aditya Birla Science & Technology Co. Pvt. Ltd.  
Nirav Bhavsar, Raghavendra Adiga, and Kaushik Vakil, Birla Copper  
Sanjay Sarkar, Hindalco Industries Limited (Unit:Birla Copper)



595038

**Chuquicamata: Quality Challenges throughout 100 Years of Copper Electrorefining and Electrowinning**

Juan Carlos Salas, Pontificia Universidad Catolica de Chile  
Ricardo A. Weishaupt and Jaime A. Guzman, Codelco Chile



595236

**Evolution of Quality Standards for Wire Bars and Cathodes**

Rodrigo Abel and Ricardo Alarcón, Codelco



595381

**Freeport-McMoRan El Paso Refinery Electrolyte Management**

Bradford C. Wesstrom, Blanca Olave, and Adriana Ramirez, Freeport-McMoRan El Paso Refinery



595425

**Freeport-McMoRan El Paso Refinery Steam Control**

Bradford C. Wesstrom and Ricardo Parra, Freeport-McMoRan El Paso Refinery



595521

**A Contemporary Approach to an Age Old Process, Using Robotics to Strip Starter Sheets for Use in a Conventional Copper Refinery**

Tracy T. Morris, ASARCO LLC  
Rodrigo Madariaga, MIRS USA | Mining & Heavy Industry Robotics



595586

**Characterization and Electrorefining of a Copper Anode with High Lead, Arsenic and Bismuth**

Charles M. Campbell and Michael S. Moats, Missouri University of Science and Technology



595638

**Experimental Measurements of the Cu Electrowinning Behavior and Current Efficiency Pre and Post Shorting**

Zongliang Zhang, University of Utah  
Joshua Werner, University of Kentucky  
Michael Free, University of Utah



595646

**Arsenic Codeposition during the Initial Phases of Nucleation and Growth on Stainless Steel in Normal Copper Electrowinning Conditions**

Florian Verbruggen, Erika Fiset, Antonin PrévotEAU, and Korneel Rabaey, Ghent University  
Tom Hennebel, Umicore R&D / Ghent University



595942

**Speciation of Iron-Arsenic-Copper-Sulfuric Acid Solution during Copper Electrorefining from 25°C to 70°C**

Yongteng Dong, and Guikuan Yue, The University of Texas at El Paso  
Bradford C. Wesstrom, Freeport-McMoRan  
John Quinn, FMI



597216

**Current Density Increase within the Last 150 Years**

Andreas Filzwieser, Martina Hanel, and Iris Filzwieser, Mettop GmbH



599250

**History of China's Electrolytic Copper Production**

Keqin Tan, Fangyuan Nonferrous Metals Ltd., Co. / Queensland University of Technology  
Changping Hu, China Nonferrous Metals Industry Association



599392

**The Historical Development of Electrolyte Additives and Their Specific Role and Influence on Cathode Quality**

J. Brent Hiskey, University of Arizona Department of Mining and Geological Engineering



601125

**Preface: The Pembrey Electrorefinery: Technological Innovation and Realization in the Victorian Era**

Jennifer Protheroe-Jones, National Waterfront Museum  
Phillip Mackey, P.J. Mackey Technology Inc.  
Albert Wraith, Private Consultant



605404

**Origins of Electro-Refining: Birth of the Technology and the World's First Commercial Electrorefinery**

Albert Wraith, Private Consultant  
Phillip Mackey, P.J. Mackey Technology Inc.  
Jennifer Protheroe-Jones, National Waterfront Museum



606676

**High Current Density Operation at Toyo Tank House**

Kazumi Takenaka, Tomoaki Yoneyama, Satoshi Matsubara, Yohei Yamaguchi, and Masaru Takebayashi, Sumitomo Metal Mining Co., Ltd.

## Health & Safety in Operations

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568074

**Worker Safety from Stray Current Shock Hazards in Electrolytic Tankhouses**

Steve Dominguez, FM Tyrone Mining LLC  
Ephrem Gebrehiwot, Steven Richardson, and Scot Sandoval, Freeport-McMoRan Mining Company



573960

**Electrical Model of an EW Circuit and Stray Current in the Connected Electrolyte Piping**






Steven Richardson, Freeport-McMoRan Mining Company









591052

**Improvement of Elements of Safety Culture in KGHM Glogow Copper Smelter**

Robert Gregorczyk and Tomasz Gąbka, KGHM Polska Mied S.A.

-  **594070**  
**Continuous Training – Insurance for Sustained Operation**  
Jackson Kapobe, Anton Lemmer, Mike Milupi, Richard Phiri, and Charles Mazala, Mopani Copper Mines plc
-  **594593**  
**Innovative Tools for Changing Behavior and Creating a Safety Culture That Reaches the Whole Workforce in a Durable Way**  
Axel Valdivieso, Corner Safety S.A
-  **594933**  
**A Structured Approach to Conducting Site Risk Reviews**  
Sudhir Thakurdin, Hatch Africa  
Thomas Gonzales, Hatch Associates
-  **595615**  
**Case Study: the Utility of the ISO 45001:2018 Framework to Generate Risk Profiles and Mitigation Strategies for the Worker / Arsine Gas Exposure Risk**  
Anastasiya Mitsui, Brian Krysa, and Terrence Koehler, Hatch
-  **599293**  
**ILTEC Technology – New Pathways towards Safe and Effective Cooling**  
Rolf Degel, SMS group GmbH  
Andreas Filzwieser and Martina Hanel, Mettop GmbH  
Hans-Jörg Krassnig, Polymet Solutions  
Timm Lux, SMS group GmbH  
Alexander Bergs, SMS

## Hydrometallurgy

-  **553398**  
**Selective Dissolution of Radionuclides from a Copper Flotation Concentrate Using Two-Stage Hydrometallurgical Leach Process**  
Weng Fu, Stefan Lakemond, and James Vaughan, The University of Queensland
-  **566372**  
**Technology Options and Innovation for Copper Heap Leaching**  
Damian Connelly, METS Engineering Pty Ltd.
-  **566375**  
**Options for Removing Arsenic and Talc from a Copper Concentrate**  
Damian Connelly, METS Engineering Pty Ltd.
-  **576516**  
**First Commercialisation of the Albion Process<sup>(TM)</sup> for Copper**  
Paul B. Voigt, Glenn M. Stieper, Mike Hourn, and Daniel P. Mallah, Glencore Technology
-  **581100**  
**Global Survey of Copper Solvent Extraction: 2018 Operating Data and Practice**  
Kathryn C. Sole, Kathryn C. Sole Consulting  
Jacob Johannes Taute, BASF Corporation  
Owen Tinkler, Solvay  
Jacklyn Steeples, Freeport-McMoRan  
Gabriel Zarate, RMV Ingehydromet
-  **582081**  
**An Undergraduate Hydrometallurgy Laboratory Emphasizing Engineering Design**  
Eduard Guerra and Jacob Schmidt, Laurentian University

-  **582615**  
**Complex Studies on Cu-Cake Leaching in Sulfuric-Acid Solutions**  
Aleksei Kritskii, Ural Federal University  
Pia Sinisalo, Aalto University  
Shila Jafari, VTT Technical Research of Finland Ltd.  
Mari Lundström, Aalto University
-  **583863**  
**Environmentally Responsible Processing of Copper-Arsenic Concentrates**  
Jan T. Smit, and Kelvin R. Buban, Sherritt International, Technologies  
M. J. Collins, and P. C. Holloway, Sherritt Technologies, Sherritt International Corporation
-  **586442**  
**Management of Copper Solvent Extraction Plants Running at Reduced Throughput**  
Godfrey Bamuanya, Mitshabu, BASF  
Didier Kachongo, Chemaf  
Albert Kashala, Ruashi Mining  
Yi Zhou, BASF
-  **589174**  
**Cu Extraction from Naturally Sourced CuFeS<sub>2</sub> Coupled to Zn Electrowinning in a Battery-Like System**  
Kashif Mairaj Deen and Edouard Asselin, The University of British Columbia
-  **589339**  
**Low-Grade Copper Concentrate Purification and Enrichment by Complex Pressure Oxidation – Hydrothermal Alteration Technology**  
Iliia Fomenko, Mikhail Pleshkov, and Yakov Shneerson, SRC Hydrometallurgy  
Alexander Shakhalov and Erzhan Ospanov, Kazakhmys Corporation  
Stanislav Naboychenko, Ural Federal University named after the first President of Russia B. N. Yeltsin
-  **590293**  
**Application of Advanced Directional Drilling and Artificial Permeability Creation for In Situ Recovery of Minerals**  
Paul Krawchuk and Raegan Brown, Hatch Ltd.
-  **590358**  
**In-situ Recovery in Hard Rock Applications: Idealistic Notion or Realistic Future Processing Option?**  
Brigitte A. Seaman, Luke Vollert, and John O'Callaghan, Newcrest Mining Ltd.
-  **590428**  
**Hydrometallurgical Strategies for Higher Impurities in Copper Refining**  
Jeff Adams, Jack Shannon, Jacqueline Fossenier, and Cinziana Sist, Hatch Ltd.
-  **590553**  
**Comparison of Chalcocite Leaching in Ferric Chloride and Cupric Chloride Media**  
Mohsen Hashemzadeh and Wenying Liu, The University of British Columbia
-  **590928**  
**The Industrial Practice of Biohydrometallurgy in Zijin Copper Mine of China**  
H. X. Li, Zijinshan Gold & Copper Mine, Zijin Mining Group Co. Ltd.  
X. J. Guo and J.H Chen, Zijin Mining Group Co. Ltd.
-  **590996**  
**Microbial Succession and Regulation during Heap Bioleaching of Copper Sulfides**  
Yan Jia, Renman Ruan, Qiaoyi Tan, Heyun Sun, Li Li, and Xiaopeng Niu, Institute of Process Engineering, Chinese Academy of Sciences





591147

**Options and Challenges in Processing Cobalt from Copper-Cobalt Ores**

Frank K. Crundwell, Ben Knights, and Nicholas du Preez, CM Solutions



591168

**Leaching of Copper Flash Furnace Dusts with Weak Acid Bleed and Arsenic Precipitation as Scorodite and Arsenical Jarosite**Antoni Roca, Universitat de Barcelona  
Guillermo Ríos and Irene Ruíz, Atlantic Copper  
Montserrat Cruells, Universitat de Barcelona

592081

**Arsenic Extraction from Chilean Copper Concentrates**

Gerardo E. Fuentes, Universidad de Chile



592408

**Development of a Cadmium Removal Process for Vale's Long Harbour Hydrometallurgy Plant**P. C. Holloway and M. J. Collins, Sherritt Technologies, Sherritt International Corporation  
R. Lopetinsky and Alain Tshilombo, Sherritt International Corporation  
T. Xue, I. Mihaylov, M. Reid, J. Vanpuymbroeck, J. Wall, and M. Jones, Vale

592846

**The Effect of Silver and Other Key Process Parameters on the Leaching of Common Primary Copper Sulfide Minerals in Sulphate Media**

Aleksandar N. Nikoloski, Glen O'Malley, and Tendekayi Tapera, Murdoch University



593047

**Reconciling Mineral Reserves at an In Situ Copper Leaching Operation**

Gary Sutton, Sutton Geological Services Ltd.



593090

**Materials for Design and Construction of Hydrometallurgical Equipment**

Kevin R. Lambrych and Joy Bennett, Ashland Corrosion Science Center



593586

**A Comparative Study of Cu Recovery from Different Primary Copper Sulfide Ores with JX Iodine Process**

Yuken Fukano, Akira Miura, and Katsuyuki Sato, JX Nippon Mining &amp; Metals Corporation



594003

**Effectiveness of Leaching Conditions in the Selective Extraction of Copper from Copper Concentrates Containing High-Arsenic under High Pressure Oxidative Leaching**

Atsushi Shibayama, Altansukh Batnasan, and Kazutoshi Haga, Akita University



594099

**How Lewatit® Ion Exchange Resins Can Add Value to Solvent Exchange Circuits**Dirk Steinhilber and Stefan Neufeind, Lanxess Deutschland GmbH  
Georgi Savov, Tedor Angelov, and Al Tsekov, Iontech Engineering Ltd.

594211

**Effect of Curing Time on Copper Leaching from Chalcopyrite**Víctor A. Quezada, Universidad Católica del Norte/Universitat de Barcelona  
Antoni Roca, Universitat de Barcelona  
Oscar Benavente, University Católica del Norte  
Montserrat Cruells, Universitat de Barcelona

-  **594492**  
**The Behaviour of Arsenic under Medium Temperature Oxidation**  
Robert T. Seaman, Teck Resources Limited
-  **594520**  
**Seeking Hydrometallurgical Pathways for Chalcopyrite Leaching: Development of a Thermodynamic Model**  
Claire-Salomé Touchard, Laboratoire de Génie Chimique / INP  
Florent Bourgeois, INPT / Laboratoire de Génie Chimique  
Carine Julcour-Lebigue and Laurent Cassayre, CNRS / Laboratoire de Génie Chimique
-  **594847**  
**Pressure Leaching of Copper-Cobalt-Zinc Containing Calcine – Outotec Pressure Oxidation Process**  
Kaarlo Haavanlammi, Outotec (Finland) Oy
-  **594898**  
**The Hydrometallurgy of Chalcopyrite in Ammoniacal Solutions**  
Thandazile Moyo and Jochen Petersen, University of Cape Town
-  **595079**  
**Electrochemical Evaluation of the Dissolution of Chalcopyrite in Cupric Chloride Solutions**  
Luis Beiza, University of Cape Town / Universidad Católica del Norte  
Jochen Petersen, University of Cape Town  
Lilian Velasquez-Yevenes, Universidad de Santiago de Chile
-  **595142**  
**Design and Optimisation of a New Hydrometallurgical Processing Route for Copper Recycling Using Process Simulation**  
Marie-Amelie de Ville d'Avray, Marie-Veronique Durance, and Etienne Braak, CASPEO  
Anne-Gwenaelle Guezennec, BRGM  
Philippe Wavrer, CASPEO
-  **595153**  
**Technological Innovation and Sustainable Competitive Advantage in the Copper Industry – The Case for Corporate Investment in Technology**  
John O. Marsden, Metallurgium
-  **595316**  
**Heap Leaching of Chalcopyrite Ores**  
Gabriel E. Zarate, Jetti Cobre SpA  
Monserrat Rebolledo and Nelson Mora, Jetti Services Canada
-  **595422**  
**Potential Impacts of in Situ Metal Recovery Processes on Microbial Ecology**  
Frank F. Roberto, Newmont Goldcorp Inc.
-  **595433**  
**New Developments in Hydrometallurgical Copper Ore and Concentrate Leaching**  
David Dreisinger, The University of British Columbia
-  **595439**  
**Process Options for Copper and Gold Recovery from a Bulk Flotation Concentrate Containing Pyrite**  
David Dreisinger, The University of British Columbia  
Felipe Hilário, Vale - Diretoria de Exploração e Projetos Minerais Tecnologia Mineral  
Mariam Melashvili and Chih Wei Chao, The University of British Columbia

-  **595448**  
**Copper Leaching from Low Grade Copper Ores Using Alternative Leaching Systems**  
Jiajia Wu, Junmo Ahn, and Jaeheon Lee, University of Arizona
-  **595449**  
**Methodology for Cover Stabilization and Installation of Drainage Pipes in a Heap Leach Cover**  
Gerardo O. Olivares, TESRA S.A. - Chile
-  **595535**  
**Arsenic Extraction from Dusts Produced in a Copper Concentrate Roasting Plant by Alkaline Leaching**  
Fernando Parada Luna, Universidad de Concepción, Chile  
Fernando Parada Torres, Consultant  
Andres Reghezza and Igor A. Wilkomirsky, Universidad de Concepción, Chile  
Javiera Salvo, Codelco Division Ministro Hales
-  **595651**  
**Processing Concentrate Leach Liquors by Solvent Extraction: Flow Distribution Considerations**  
Thivanka S. Ratnaweera and Brandon Wellbrook, Freeport-McMoRan  
Tyler McCallum, Solvay
-  **595661**  
**Recovery of Value-Added Metals from Copper Refining Streams Using Molecular Recognition Technology**  
Neil Izatt, Steven Izatt, Ronald Bruening, Reed Izatt, and Luis Navarro, IBC Advanced Technologies, Inc.  
Shijie Wang, Rio Tinto
-  **595679**  
**Kinetics of Chalcopyrite Leaching in Novel and Exotic Lixiviants**  
Isabel F. Barton and J. Brent Hiskey, University of Arizona Department of Mining and Geological Engineering
-  **595735**  
**Controlling Crud Formation in Solvent Extraction with ACORGA® CR60 PLS Additive**  
Tyler McCallum, Troy Bednarski, Bravo Mbao, Luis Moya, and Lambert Nsenga, Solvay
-  **595743**  
**Enhanced Leaching of Chalcopyrite in Ferric Sulfate Media by the Presence of Iodide/Iodine**  
Ronny Winarko and David Dreisinger, The University of British Columbia  
Akira Miura, JX Nippon Mining & Metals Corporation  
Wenyong Liu, The University of British Columbia
-  **595754**  
**Extended Validation of an Expression to Predict ORP: Application to Pregnant Leaching Solution Generated during Heap Leaching and Copper Electrowinning Solution**  
Jiahao Xu, Namsoo Kim, and Guikuan Yue, The University of Texas at El Paso
-  **596010**  
**The Interaction of Chalcopyrite with Silver Ions in Sulfuric Acid Solution**  
Lin Li and Ahmad Ghahreman, Queen's University
-  **596300**  
**Parameter Study of the Activated Carbon-Catalyzed Arsenic Oxidation Process under Dynamic and Continuous Conditions**  
Chengqian (Charles) Wu and Ahmad Ghahreman, Queen's University
-  **596815**  
**Behaviour of Selenium Contained in Copper Anode Slimes by Oxidizing Alkaline Leaching**  
Evelyn Melo, María Cecilia Hernández, and Oscar Benavente, University Católica del Norte

-  **597057**  
**Early Innovations in Copper Hydrometallurgy: The Unknown 1866 Whelpley & Storer Process**  
William W. Culver, SUNY Plattsburgh
-  **597207**  
**Differences between Column and Heap Leaching and Their Implications for Laboratory and Operational Practice**  
Petrus Johannes van Staden, Mintek  
Jochen Petersen, University of Cape Town
-  **597297**  
**Heap Leaching of Copper Ores – State of the Science**  
Jochen Petersen, University of Cape Town
-  **597328**  
**Upgrading Copper Sulphide Concentrates through High Temperature Metathesis Reactions**  
William Hawker, Kelly Byrne, and James Vaughan, The University of Queensland
-  **598117**  
**Maximizing Performance of FRP Equipment in Copper Extraction and Lessons Learned**  
Jeffrey D. Eisenman, Maverick Applied Science, Inc.
-  **598185**  
**Solvent Extraction of Copper Using Microstructured Droplet Generator**  
Rohan Sharma, Ilija Miskovic, and Sanja Miskovic, The University of British Columbia
-  **606675**  
**Precious Metal Recovery Process Using Hydrometallurgical Technologies of Copper Anode Slime**  
Takayuki Nakai, Masahiro Shingu, Hidemasa Nagai, Yasushi Isshiki, Satoshi Asano, and Masaru Takebayashi, Sumitomo Metal Mining Co., Ltd.
-  **616561**  
**Teck's Secondary Leaching Technology**  
Hector Lizama and Rob Stephens, Teck Metals Ltd.

## Mineral Processing

-  **574722**  
**Forecasting SAG Mill Energy Consumption Using Gated Recurrent Units**  
Sebastian Avalos. Sotomayor, Queen's University  
Willy Kracht, Department of Mining Engineering, Universidad de Chile  
Julian M. Ortiz, Queen's University
-  **576320**  
**The Order in the Disorder: Quantitative Analysis of XRF Sorters**  
Arvin Mazhary, Arvin M. Consulting  
Tyler Huff, Steinert US
-  **587409**  
**Study of the Surface Interaction between Copper Sulfide Minerals and NaHS as Flotation Activator**  
Hidekazu Matsuoka, Nittetsu Mining Co., Ltd.
-  **590126**  
**The Application of Froth Flotation Technology to Copper in Canada in the Early 20th Century**  
Jan E. Nasset, NesseTech Consulting Services Inc.  
Erin R. Bobicki and Ksenia L. Bilaniuk, University of Toronto



590511

**Reagent Optimization for Improved Selectivity of Floating Copper Minerals Against Pyrite**

Alice Shi, Bureau Veritas Minerals  
Jinxing Ji, Eldorado Gold Corporation  
Boja Grcic, Bureau Veritas Minerals



593930

**Newcrest's Industry First Application of Eriez Hydrofloat™ Technology for Copper Recovery from Tailings at Cadia Valley Operations**

Luke Vollert, Brandon Akerstrom, and Brigitte A. Seaman, Newcrest Mining Ltd.  
Jaisen Kohmuench, Eriez



593932

**Grinding Chemistry and Its Impact on Copper Flotation**

Christopher J. Greet, Magotteaux Australia Pty Ltd.



593963

**Orfom® D8: A Viable Replacement for NaHS as a Depressant in the Chalcopyrite-Molybdenite Flotation System**

Simon Timbillah, Richard LaDouceur, and Avimanyu Das, Montana Technological University  
Courtney A. Young, Metallurgical Engineering / Montana Technological University



594058

**Investigation on Flotation Behavior of a Copper Sulfide Ore after Dry Grinding by Loesche Vertical Roller Mill**

Janet Katzmarzyk, Klaus M. Hahn, Ivan Silin, and Hermann Wotruba, Unit of Mineral Processing (AMR) - RWTH Aachen University  
Carsten Gerold and Markus Stapelmann, Loesche GmbH



594195

**Surface Interactions between Biopolymers as Biofloculants and Clay Minerals in Mining Tailings**

Nahid Molaei and Erin R. Bobicki, University of Toronto



594667

**Numerical Investigation of Slurry Flow and Particle Segregation Dynamics in a New Type of Gravity Concentrator**

Utkan Caliskan and Sanja Miskovic, The University of British Columbia



594807

**Separation of Molybdenite and Chalcopyrite Using Various Oxidation Treatments**

Gde Pandhe Wisnu Suyantara, Kyushu University  
Tsuyoshi Hirajima, Kyushu University & Sumitomo Metal Mining Co., Ltd.  
Hajime Miki and Keiko Sasaki, Kyushu University  
Masashi Yamane, Eri Takida, Shigeto Kuroiwa, Yuji Imaizumi, and Mitsuru Sawada, Sumitomo Metal Mining Co., Ltd.



594835

**Applied Process Mineralogy at Kansanshi Mine: Changing Perceptions and Unlocking Value**

Lucy J. Little, Andre Prinsloo, and Crosby Chongo, Kansanshi Mining Plc., First Quantum Minerals



594915

**Flotation of a Porphyry Copper Ore with Cellulose-Surfactant Mixtures as Frother Agents**

Ted Nuorivaara and Rodrigo Serna-Guerrero, Aalto University



595345

**Geometallurgical Design for a Large Copper-Molybdenum Concentrator**

David R. Hatton, SGS



595371

**tph/Cubic Metre - An Alternative Approach to High Density and Paste Thickener Design**

David N. Minson, MinTecProcess Consulting &amp; Management Ltd.



595614

**Nitrogen-Based Collectors for Sulfide Flotation – Tecflote™**

Peter Zhou, Andrew Lewis, Henrik Nordberg, Mikael Widell, Magnus Svensson, Alireza Movahedi, Wan WangGeissler, and Joseph Zachwieja, Nouryon



595846

**Targeted Mineralogy in Informing Compositing and Detailed Analysis for Geometallurgy: A Cu Porphyry Case Study**

Christopher C. Hamilton, Thomas C Chudy, and Geoffrey R. Lane, Process Mineralogical Consulting Ltd.



596753

**Solids Sampling at Australian Iron Ore Mine Sites**

Jimmy Zhang and Alex Vo, Consep



597473

**Improvement of Cleaner Flotation Columns at Miduk Copper Concentrator**Mohammad Massinaei and Saeid Abbasi, University of Birjand  
Manochehr Oliazadeh, Lycopodium Minerals Canada

597614

**Nuevaunión - Applying Capital and Infrastructure Synergies to Support Development of the Relincho and La Fortuna Deposits**Walter Bergholz, NuevaUnion  
Peter J. Lind, Newmont Goldcorp  
Cassandra Spence, Teck Resources Ltd.  
Claudia Velasquez, NuevaUnion

597952

**Going Coarser: Is It Worth It?**

Laurie Reemeyer, Resourceful Paths



599011

**Physical and Mineralogical Impact of Copper Concentrate on Transportable Moisture Limit (TML)**

Masoud Garshasb, Freeport-McMoRan



600848

**The Real Cost of Material Handling Issues**

Carrie Hartford and Tracy Holmes, Jenike &amp; Johanson Ltd.



600959

**An Integrated Approach for Characterization, Selection, and Development of Tailored Frother Formulations**

Esau Arinaitwe, Solvay



601128

**Co-Dependencies in Copper: Production, Price and Innovation Trends 1900-2018**

Andrew Bamber, Bara Consulting Ltd.



601131

**The Evaluation of Bulk Sorting Systems for Open Pit Copper Mines**Andrew Bamber, Bara Consulting Ltd.  
Bernhard Klein, The University of British Columbia



601296

**A High Rate Mechanical Flotation Cell for Base Metal Applications**

Eric Bain Wasmund, Mike Mankosa, Homie Thanasekaran, Nee San Yap, and Eric Yan, Eriez Flotation Division USA



602444

**Pyrrhotite Rejection at Strathcona Mill – DETA/SMBS Plant Trials**

Ravinder Multani, XPS  
Curtis Deredin and Julie Coffin, Glencore, Sudbury Integrated Nickel Operations  
Gordon Marrs, XPS  
Virginia Lawson, Glencore Technology



606917

**The Jameson Cell for Pre-Rougher Applications in Base and Precious Metals**

Virginia Lawson and Adam Price, Glencore Technology

## Process Control, Optimization, & Instrumentation



591116

**Development and Calibration of an Autogenous/Semi-Autogenous Mill Simulation Model for Process Control Applications**

Edgar Manuel Pérez García, Jocelyn Bouchard, and Éric Poulin, Université Laval



592114

**Rougher Flotation Cell Pulp Level Control to Increase Recovery**

Mark A. Ferra, REXA Inc.



592336

**Maximize Benefits from Your Control Systems**

Michel Ruel, BBA



593106

**Peirce-Smith Converters: Automation, Design, Operation and Environmental Improvements at Kansanshi Smelter**

Nurzhan Dyussekenov, James Rajith, Lawrence Hanschar, Paul Mascrenhas, and David deVries, Kansanshi Mining Plc.



593695

**Evaluation of Artificial Intelligence for Improved Plant Operation**

Alain Tshilombo, Cory Kosinski, Vijay Reddy, and Kelvin Buban, Sherritt International Corporation  
Chowdary Meenavilli, Siddhartha Tirumalaraju, and Sriraj Meenavilli, NTWIST



594047

**VIS-NIR Spectroscopy Applied to Copper Flash Smelting Processes**

Sergio NEFTALI. Torres, Universidad de Concepción, Chile  
Carlos Toro, Universidad Tecnológica de Chile INACAP  
Eduardo Balladares, Roberto Parra, Victor Parra, Daniel Sbarbaro, Luis Arias, Milton Marin, Gonzalo Reyes, Walter Díaz, Universidad de Concepción, Chile



594059

**Iron and Copper Oxide Molecular Emissions Detection in Flash Smelting Processes**

Sergio NEFTALI. Torres, Universidad de Concepción, Chile  
Carlos Toro, Universidad Tecnológica de Chile INACAP  
Victor Parra, Roberto Parra, Eduardo Balladares, Daniel Sbarbaro, Luis Arias, Milton Marin, Cristofher Godoy, Gonzalo Reyes, Walter Díaz, and Rodrigo Fuentes, Universidad de Concepción, Chile



594127

**Innovative Technology Provides for On-Line Measurement of Particle Size in Individual Cyclones**

Dylan Cirulis and Joseph Poplawski, CiDRA Minerals Processing Inc.



594735

**Using Real Time Elemental Analysis of Conveyed Ore Flows to Improve Copper Processing**

Henry Kurth, Scantech International Pty Ltd.



594908

**Outotec's Fully Automated Smelter 2020 – the Vision, the Status and the Future**

Jani Jansson, Mikko Korpi, and Mikael Jåfs, Outotec (Finland) Oy

Joey Hoang, Outotec Pty Ltd.

Robert Johansson, Outotec (Sweden) AB

Tapani Keronen, Outotec (Finland) Oy



594913

**Transfer of an Optimization System from Zinc to Copper Roasting Plants**

Marcus Runkel, Steffen Haus, and Joerg Hammerschmidt, Outotec



595314

**Monitoring Furnace Sidewall Integrity Using Multivariate Statistical Models**

Ravi Pula, Terry Gerritsen, Tom Plikas, and Richard MacRosty, Hatch Ltd.

Jennifer Reichart, Kenly Ochoa, and Mike Loveless, Rio Tinto Kennecott Copper



595322

**Auction-based Control as a Site Implementable Means of Stabilising the Movement of Material through a Set of Countercurrent Decantation Thickeners**

Bryan Maas, First Quantum Minerals



595342

**Advance Control and Real-time Optimization's Emerging Trends in Copper and Mineral Processing**

Robert K. Jonas, Honeywell



595404

**Data Mining for Copper Concentrate Forecasting - Revisiting Old Problems with New Weapons**

Jorge Torrealba, Andre Allaire, and David Runnels, BBA Inc.



595533

**Advanced Thermodynamic Modeling in the Pyrometallurgy - Refractory Corrosion Simulations**

Christoph Pichler, Christoph Wagner, and Daniel Kreuzer, RHI Magnesita

Christoph Sagadin and Stefan Luidold, Montanuniversitaet Leoben



595585

**Hyperspectral Remote Sensing Characterization of Mine Materials for Process Control**

Isabel F. Barton, University of Arizona Department of Mining and Geological Engineering

Matthew Gabriel and Mark D. Barton, University of Arizona Department of Geosciences







595775

**Automating SAG Mill Speed Control at Gibraltar Mine**


Alex Day, Gibraltar Mines

Ken McClure, Spartan Controls



-  **597580**  
**Monitoring the Burner Emission Spectrum in a Commercial Flash Furnace Using a Novel Optical Probe**  
Arthur Stokreef, Queen's University  
Trevor Lebel, Kingston Process Metallurgy  
Gerardo Raul Fernando Alvear Flores and Milen Kadiyski, Aurubis AG  
Peter Looock and Jack Barnes, Queen's University  
Boyd Davis, Kingston Process Metallurgy
-  **598094**  
**Improving Analytical Assessment in Copper Industry Based on Laser-induced Breakdown Spectroscopy (LIBS) and UV-Vis-IR Hyperspectral Sensing**  
Jorge Yáñez, Claudio Sandoval, Jonnathan Alvarez, Rodrigo Fuentes, Roberto Parra, Daniel Sbarbaro, Rosario Castillo, Sergio Neftali Torres, Ashwin Kumar Myakalwar, and Eduardo Balladares, Universidad de Concepción, Chile
-  **599109**  
**Copper Production Increase at the Horne Smelter**  
Guillaume Dion and Yves Prevost, Glencore - Horne Smelter
-  **600894**  
**Advanced Control Optimization for Copper Concentration Plants**  
Sohail Nazari and Tomas Carricajo, Andritz Inc.

## Pyrometallurgy (The Phillip Mackey Symposium)

-  **528496**  
**Twenty Five Years of Sonic Injection Plant Trials and Implementation — Let's Take Stock**  
Joel Kapusta, BBA Inc.
-  **547828**  
**China Nerin's Side-blown Furnace Technology and Its Application**  
Wei Wang, China Nerin Engineering Co., Ltd.
-  **561070**  
**Investigating the Combustion Conditions of TSL Lance in an Ambient Atmosphere**  
Avinash Kandalam, TU Bergakademie Freiberg  
Jörg Kleeberg, CIC Virtuhcon  
Michael Stelter, TU Bergakademie Freiberg  
Markus Reuter, Helmholtz Institute Freiberg for Resource Technology
-  **567788**  
**Typical Wear Phenomena Observed on Refractories out of the Copper Peirce-Smith Converter and Copper Anode Furnace**  
Dean Gregurek, Katja Reinharter, Jürgen Schmidl, and Alfred Spanring, RHI Magnesita
-  **572932**  
**Flash Furnace Dust Handling Systems for Flash Furnaces**  
Mark Coleman, Schenck Process UK Ltd.
-  **573354**  
**Development and Applicability of a New Corrosion Test to Quantify Refractory Wear Due to Gaseous Sulphur Oxides Action**  
Daniela M. Fonseca, Graziella Pacheco, Wagner Moulin-Silva, Geraldo Goncalves, and Rainer Neuböck, RHI Magnesita



575170

**A Kinetic Model of Anode Copper Reduction and Its Comparison with Industrial Data**

Paul E. Mather and Matthew Krane, Purdue University



582625

**"Around the Copper World in Eighty Days": A Virtual Tour of World Copper Operations and Technologies**Phillip Mackey, P.J. Mackey Technology Inc.  
Tony Warner, Advisian WorleyParsons Group

586813

**On the Use of Copper Concentrates Blended with Complex Gold Concentrate for Gold Recovery Using the SKS Smelting Process**

Jie Yan, China ENFI Engineering Corporation



587855

**Exposition of Applications of Uncertainty Quantification to Modeling Pyrometallurgical Processes Using a Model of Copper Fire Refining as an Example**

Paul E. Mather and Matthew Krane, Purdue University



587988

**Flash Furnace Feed System Developments**Michael E. Reed, Front End Solutions, Worley Pty Ltd.  
Mark Coleman, Schenck Process UK Ltd.

588809

**Application and Development of Modern Copper Metallurgical Technologies in China's Copper Industry**

Bin Tang and Suping Yao, China Nerin Engineering Co., Ltd.



589693

**Roasting of High Arsenic Copper Concentrates: Kinetics and Mechanism of Calcine Formation**

Igor A. Wilkomirsky, Fernando Parada Luna, Roberto Parra, and Eduardo Balladares, Universidad de Concepción, Chile



589867

**The Influence of Sodium on the Burning Behavior of Copper Matte Particles in Flash Converting Process**

Longgong Xia, Feng Yu, Haibao Shao, Yu Shen, and Leiting Yue, School of Metallurgy and Environment, Central South University

Peng Ren, Tongling Nonferrous Metals Group Holding Co.

Zhihong Liu, School of Metallurgy and Environment, Central South University



590163

**Fluid Dynamic Studies of Bottom-Blown and Side-Blown Copper Smelting Furnaces**

Xiaodong Ma, The University of Queensland

Zhixiang Cui, Dongying Fangyuan Nonferrous Metals Co., Ltd.

Leonel Contreras, National Copper Corporation of Chile

Xu Jiang, Mao Chen, and Baojun Zhao, The University of Queensland



590204

**Visualization of Bubbly Flows Injected by a Top Submerged Lance (TSL) in a Liquid Metal Layer by X-ray Radiography**

Megumi Akashi, Helmholtz Zentrum Dresden Rossendorf

Daniele Obiso, CIC Virtuhcon / Institute of Energy Process and Chemical Engineering

Olga Keplinger and Natalia Schevchenko, Helmholtz Zentrum Dresden

Markus Reuter, Helmholtz Institute Freiberg for Resource Technology

Sven Eckert, Helmholtz Zentrum Dresden



590691

**A Novel Process for Arsenic Removal from Dusts Produced in Chilean Copper Smelting**

Hector Mario. Henao, Technical University Federico Santa Maria  
Rodrigo Antonio. Diaz, Ministro Hales División, Codelco Chile  
Ignacio Andres. Paredes, Technical University Federico Santa María  
Javier Ortiz, Ministro Hales División, Codelco Chile



590977

**Evaluation of Copper Losses Using Flow Patterns in the CL-furnace of the Mitsubishi Process**

Masahiro Kato, Hiroyuki Sakurai, and Fumito Tanaka, Mitsubishi Materials Corporation



590991

**Experimental Study of the Gas/Slag/Matte/Spinel Equilibria in the "Cu<sub>2</sub>O"-FeO-SiO<sub>2</sub>-S- Al<sub>2</sub>O<sub>3</sub>-CaO-MgO System**

Svetlana Sineva, Taufiq Hidayat, Denis Shishin, Maksym Shevchenko, Peter C. Hayes, and Evgueni Jak, PYROSEARCH, Pyrometallurgy Innovation Centre, The University of Queensland



591007

**Introduction of China's Copper Converting Technologies**

Feng He and Huilan Yang, China Nerin Engineering Co., Ltd.



592129

**Heat Balance Control Changes- Further Steps and Safety Issues**

Michael E. Reed, Front End Solutions, Worley Pty Ltd.  
Robert C. West, Tak Seng Kho, and WeiWei V. Zhang, Worley Pty Ltd.



592158

**Selection of Smelting Process for High-Copper /Sulphur Ratio Copper Concentrate**

Feng He, Metallurgy Business Division, China Nerin Engineering Co., Ltd.  
Wei Ye, China Nerin Engineering Co., Ltd.  
X. J. Guo, Zijin Mining Group Co. Ltd.  
Lei Li, Kunming University of Science and Technology



592261

**Recent Progress of the "O-SR Process" Technology**

Takuro Nagata, Isamu Ueda, and Shigeru Ishikawa, Onahama Smelting & Refining Co., Ltd.



592323

**Cobalt Recovery from Southern African Copper Smelters**

Rodney T. Jones, Mintek and University of the Witwatersrand  
Christoph Pawlik, Mintek



592732

**The 2019 Copper Smelting Survey**

Joel Kapusta and Liam Watt, BBA Inc.



592797

**Enhancing Cobalt Recovery from Copper/nickel Matte Producing Smelters**

Ramamritham Sridhar, V. I. Lakshmanan, and Jonathan Chen, Process Research ORTECH Inc











592806

**Oxidic Systems: A Combined Modelling and Experimental Approach**

Inge Bellemans and Vincent Cnockaert, Ghent University  
Evelien De Wilde, Umicore Group Research & Development  
Nele Moelans, KU Leuven  
Kim Verbeken, Ghent University

-  **592917**  
**Engineering and Production Practice of Double Bottom-blowing Continuous Copper Smelting Process with Three Connected Furnaces Arrangement**  
Yongcheng Zhao, Bing Li, and Kai Liu, China ENFI Engineering Corporation
-  **593054**  
**Maximizing Energy Efficiency in Smelter Feed Drying**  
Jukka Tuominen and Carl-Gustav Berg, Kumera Technology Center
-  **593086**  
**CFD-DEM Modelling of Matte Droplet Behavior in a Flash Smelting Settler**  
Jani-Petteri Jylhä and Ari Jokilaakso, Aalto University
-  **593109**  
**Kansanshi Copper Smelter: the First Four Years of Operation**  
Simon P. Hunt and David deVries, Kansanshi Mining Plc.
-  **593111**  
**Anode Furnace Nitrogen Gas Purging System at Kansanshi Copper Smelter**  
Edmond Mokola, Coaster Bwalya, Kelly Musonda, Alex Makayi, and Lawrence Hanschar, Kansanshi Mining Plc.
-  **593348**  
**Mineralogical Characterization and Metallurgical Processing of Seafloor Massive Sulfides from the German License Area in the Indian Ocean**  
Marcus Sommerfeld and David Friedmann, Department of Process Metallurgy and Metal Recycling (IME), RWTH Aachen University  
Ulrich Schwarz-Schampera, Federal Institute for Geosciences and Natural Resources (BGR)  
Bernd Friedrich, Institute of Process Metallurgy and Metal Recycling (IME), RWTH Aachen University
-  **593815**  
**Integrated Experimental and Thermodynamic Modelling Study of the Multicomponent "Cu<sub>2</sub>O"-FeO-Fe<sub>2</sub>O<sub>3</sub>-CaO-SiO<sub>2</sub>-PbO-ZnO-Al<sub>2</sub>O<sub>3</sub> System for Copper Smelting**  
Maksym Shevchenko, Viktoria Prostavkova, and Evgueni Jak, PYROSEARCH, Pyrometallurgy Innovation Centre, The University of Queensland
-  **593850**  
**Distribution of Minor Elements in the Process of Copper Smelting: Plant Mass Balance and Thermodynamic Analysis**  
Hua Wang and Lei Li, Kunming University of Science and Technology  
X. J. Guo, Zijin Mining Group Co. Ltd.
-  **593852**  
**Thermodynamic and Process Evaluation of Direct Blister Copper Smelting**  
Hua Wang and Lei Li, Kunming University of Science and Technology  
X. J. Guo, Zijin Mining Group Co. Ltd.  
Hua Wang, Kunming University of Science and Technology
-  **593860**  
**Dust Reaction Model in Waste Heat Boiler of Copper Smelting**  
Seung Hwan Ahn, Moosang Lee, and Jongshin Chang, LS-Nikko Copper Inc.  
So-Yeong Lee and Ho-Sang Sohn, Kyungpook National University School of Material Science and Engineering
-  **593874**  
**Arsenic Challenge and Control in Zijin Copper Smelter**  
Qiankun Wang and S.P. Zhong, State Key Laboratory of Comprehensive Utilization of Low Refractory Grade Gold Ore at Zijin Mining Group Co. Ltd.  
X. J. Guo, and J.H. Chen, Zijin Mining Group Co. Ltd.

-  **593961**  
**Towards Comprehensive Model of the Flash Smelting Furnace**  
Ari Jokilaakso and Pekka Taskinen, Aalto University
-  **593980**  
**Behaviour of Mo and Ir in Copper Matte Smelting**  
Pekka Taskinen, Dmitry Sukhomlinov, Lassi Klemettinen, and Ari Jokilaakso, Aalto University
-  **593984**  
**Design of Sidewall Copper Cooling Systems for Copper Smelting and Converting Furnaces**  
Hugo Joubert, Isobel Mc Dougall, and Gerrit de Villiers, Tenova Pyromet, Tenova South Africa (Pty) Ltd.
-  **593985**  
**Risk Management Approach to Taphole Integrity at Olympic Dam Copper Smelter**  
Farai Musuka, Danny Jenkins, and Adrian Keyes, BHP
-  **593987**  
**Mechanism of Slag and Matte Formation in Copper Flash Smelting**  
Jun Zhou, Tongling Nonferrous Metals Group Holding Co., Ltd.
-  **593993**  
**Innovative Technologies for Copper Smelting and Electric Slag Cleaning and Matte Settling Furnaces**  
Andre Esterhuizen, Hugo Joubert, Saskia Essack, and Nico Fowler, Tenova Pyromet, Tenova South Africa (Pty) Ltd.
-  **594002**  
**Electrode and Electrode Management Technology for Base Metal Electric Furnaces**  
Simbongile Bantubani, Ravith Hansraj, Sachin Arjun, Hugo Joubert, and Isobel Mc Dougall, Tenova Pyromet, Tenova South Africa (Pty) Ltd.
-  **594062**  
**Challenges in Pneumatic Conveying of Concentrate and Flue Dust at Copper Smelters**  
Jyri J. Talja, Roni Jahila, and Eero Lehtila, Kopar Oy
-  **594617**  
**Renewal of the Saganoseki Flash-Smelting Furnace**  
Jae Hyung Hong, Yuki Soma, Tsutomu Ogawa, and Toshihiro Nagato, Pan Pacific Copper Co., Ltd.
-  **594634**  
**Application of Bottom Blowing Continuous Converting to Replace Copper P-S Converter**  
Hongfei Li, Yongcheng Zhao, and Jianlong Wang, China ENFI Engineering Co., Ltd.
-  **594647**  
**Decarbonisation of the Outotec® Ausmelt Process**  
Jacob Wood and Robert Matuszewicz, Outotec Pty Ltd.
-  **594752**  
**Evaluation Copper Slag Cleaning Potentials**  
Eric Klaffenbach, Aurubis  
Muxing Guo and Bart Blanpain, KU Leuven  
Sina Mostaghel, Aurubis
-  **594756**  
**Successful Treatment of Complex Feeds through the ISASMELT™ and Albion Process™**  
Stanko Nikolic, Ben J. Hogg, Daniel P. Mallah, Glenn M. Stieper, Paul B. Voigt, and Mike Hourn, Glencore Technology



594775

**Modification of Feeding System for the Smelting Furnace and Other Recent Improvements at Gresik Copper Smelter**

Ahmad Munib Fikry, Dadang Sundana, Kenta Kusunose, and Yosuke Unno, PT Smelting, Gresik Copper Smelter & Refinery



594783

**Detailed OPEX Comparison of Modern Copper Smelting Technologies Using HSC-SIM Modelling**

Lauri Pesonen, Ali Bunjaku, and Hannu Johto, Outotec (Finland) Oy



594800

**The Past 70 Years of Flash Smelting**

Mikael Jåfs, Outotec (Finland) Oy  
Petri Latostenmaa and Esa J. Peuraniemi, Boliden Harjavalta  
Ilkka Kojo, Mari Lindgren, Satu Jyrkönen, and Markku Lahtinen, Outotec (Finland) Oy



594802

**The Distribution of Ni between Slag and Copper Metal under Copper Fire-Refining Conditions**

Amy Van den Bulck, KU Leuven  
Denise Willems, Aurubis Belgium  
Muxing Guo, Annelies Malfliet, and Bart Blanpain, KU Leuven



594822

**Review of Boliden Harjavalta Copper Smelter**

Esa J. Peuraniemi, Tommi Veneranta, Petri Latostenmaa, and Juha Järvi, Boliden Harjavalta



594836

**Outotec® Flash Smelting Technology Development**

Jaana Romppanen, Peter Björklund, Kaj Eklund, Tiina Ranki, Markku Lahtinen, Satu Jyrkönen, and Päivi Suikkanen-Halmela, Outotec



594846

**Advances in Complex Concentrate Smelting at the DPM Tsumeb Smelter**

Mirco Nolte, Dundee Precious Metals  
Buks Kruger, Dundee Precious Metals Tsumeb



594861

**Development and Applications of Thermodynamic Database in Copper Smelting**

Denis Shishin, Peter C. Hayes, and Evgueni Jak, PYROSEARCH, Pyrometallurgy Innovation Centre, The University of Queensland



594870

**On the Origin of Sudden Slag Foaming during Copper Smelting**

Vincent Cnockaert, Ghent University  
Tijl Crivits, Umicore  
Inge Bellemans, Ghent University  
Bart Blanpain, KU Leuven  
Kim Verbeken, Ghent University



594874

**Macroscopic Analysis of the Reaction between Molten Copper and Water: Simulations and Preliminary Experiments**

Arne Simons and Inge Bellemans, Ghent University  
Tijl Crivits, Umicore  
Kim Verbeken, Ghent University



594899

**Fundamental Analysis for an Improved Multi Metal Recovery by Combining Copper and Lead Metallurgy**

Christoph Zschiesche, Gerardo Raul Fernando Alvear Flores, and Mehmet Ayhan, Aurubis AG  
Jürgen Antrekowitsch, Montanuniversität Leoben Austria



594909

**CFD Modelling of Top-Submerged-Lance Argon Injection in Liquid Metal**

Daniele Obiso, CIC Virtuhcon / Institute of Energy Process and Chemical Engineering  
Megumi Akashi, Helmholtz Zentrum Dresden Rossendorf  
Sven Eckert, Helmholtz Zentrum Rossendorf Dresden  
Markus Reuter, Helmholtz Institute Freiberg for Resource Technology  
Sebastian Kriebitzsch, CIC Virtuhcon / Institute of Energy Process and Chemical Engineering



595113

**Environmental Upgrade at the Freeport-McMoRan Miami Smelter**

David M. Jones, Robert W. Brandt, Avi Nanda, and Alexander J.H. Piatkiewicz, Freeport-McMoRan



595333

**Use of Flotation Tails as Flux in Copper Smelting**

Hector Mario Henao, Technical University Federico Santa Maria  
Francisca C. Canales, Anglo American  
Claudio Pizarro, Codelcotech



595369

**Effect of CaO and Al<sub>2</sub>O<sub>3</sub> on the Liquidus Lines of the Cu<sub>2</sub>O-Fe<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> System in Equilibrium with Metallic Copper**

Hector Mario Henao, Erik Kohenkamp, and Lisa Rojas, Technical University Federico Santa Maria



595570

**Quantitative Methods for Copper Smelter Reengineering Projects**

Alessandro Navarra and Andrés Ross, McGill University  
Norman Toro and Fernando Ayala, Universidad Católica del Norte  
Tanai Marín, M4Dynamics



595641

**Campaign Life Extension and Refractory Management of Copper Making Furnaces**

Majid Maleki, Afshin Sadri, Marcio Caçador, Hamid Ghorbani, and Blair Climenhaga, Hatch  
Thomas Gonzales, Hatch Associates



595805

**Anode Furnace Off-Gas NO<sub>x</sub> Emission Improvements at Rio-Tinto Kennecott Copper**

Adrian Deneys, Praxair, Inc.  
Arsenio Enriquez, Ryan Walton, and Jenny Esker, Rio Tinto Kennecott Copper



595879

**The Utilization of Copper Continuous Smelting, Converting and Fire-Refining Process in China**

Ling Wu, China ENFI Engineering and Technology Corporation



595889

**Complex Copper Pyrometallurgy Challenges and Opportunities - Integrated Experimental Phase Equilibria and Thermodynamic Modelling Research and Implementation**

Evgueni Jak, Taufiq Hidayat, Denis Shishin, Viktoria Prostavkova, Maksym Shevchenko, and Peter C. Hayes, PYROSEARCH, Pyrometallurgy Innovation Centre, The University of Queensland



595947

**Copper Smelting: 2019 World Copper Smelter Data**

Shijie Wang, Rio Tinto  
William G. Davenport, University of Arizona  
Suping Yao, China Nerin Engineering Co., Ltd.  
Andreas Siegmund, LanMetCon  
Thomas Gonzales, Hatch Associates  
Gary Walters, Hatch  
David B. George, David B. George and Associates, LLC



595999

**Optimization of the Refractory Lining Life of Copper Converters**

Anthony J. Rigby, HWI Refractories



596538

**Comparison of Two Sizes of FSFs in the Głogów Copper Smelter**

Roksana Urbaniak, Tomasz Gąbka, Piotr Poks, and Leszek Garycki, KGHM Polska Mied S.A.



596675

**Experimental Investigation of Phase Equilibria of Major Elements and Distributions of Minor Elements between Slag/Metal and Slag/Matte at Tridymite Saturation in "Cu<sub>2</sub>O"-FeO-SiO<sub>2</sub>-S-Al<sub>2</sub>O<sub>3</sub>-CaO System**

Taufiq Hidayat, Peter C. Hayes, and Evgueni Jak, PYROSEARCH, Pyrometallurgy Innovation Centre, The University of Queensland



596677

**Dr Phillip J. Mackey - A Lifetime of Achievement**

John B. See, SeeBruce Solutions



596763

**When to Chose Direct to Blister Smelting Process**

Robert C. West and Tak Seng Kho, Worley Pty Ltd.  
Michael E. Reed, Front End Solutions, Worley Pty Ltd.  
Lincoln Thompson, WorleyParsons



597294

**Slag Reduction and Settling for Improved Metal Recovery**

Boyd Davis, Trevor Lebel, Chris Pelow, and Russell Dawes, Kingston Process Metallurgy



597310

**Effect of Mineralogy on the Flash Combustion of Concentrates**

Trevor Lebel, Kingston Process Metallurgy  
Gerardo Raul Fernando Alvear Flores, Victor Montenegro, and Milen Kadiyski, Aurubis AG  
Roberto Parra, Universidad de Concepción, Chile  
Arthur Stokreef, Queen's University  
Boyd Davis, Kingston Process Metallurgy



598518

**ASARCO LLC Hayden Smelter Converter Retrofit Project—An Update**

Krishna Parameswaran, tfgMM Strategic Consulting  
Amy Veek, ASARCO LLC Hayden Operations  
Matt Russell and Paykan Safe, Gas Cleaning Technologies LLC  
Alberto Fernandez, ASARCO LLC Hayden Operations



598757

**Thermodynamic Modeling of Copper Chloride-Containing Systems in High Temperature Processes**

Daniel Lindberg, Hanna Viitala, and Pekka Taskinen, Aalto University





599263

**Innovative Solutions in Non-Ferrous Metals Production Lines**

Rolf Degel, Johannes Joubert, and Timm Lux, SMS group GmbH  
Andreas Filzwieser Martina Hanel, Mettop GmbH



599770

**Deportment Behaviour of Sn in Copper Smelting**

Chunlin Chen, CSIRO Mineral Resources



600345

**Development and Improvement of Submerged Lance Converting & Refining Furnace of Dongying Fangyuan's Two-Step Process**

Zhi Wang, Zhixiang Cui, Haibin Wang, Wenzhao Cui, and Zhiwei Huang, Dongying Fangyuan Nonferrous Metals Co., Ltd.



602421

**Comparison of Smelting Technologies**

Thomas Gonzales, Hatch Associates  
Matthew White and Gary Walters, Hatch



616560

**Optimization Initiatives at Altonorte on the Path to Becoming a World Class Smelter**

Juan Carrasco and Beatrice Pierre, Altonorte - Glencore

## Sustainability & Waste Management



538079

**A Comparison of Roasting Technologies for Arsenic Removal from Copper Concentrates**

Kamal Adham and Cassandra Lee, Sabrina Francey, and A.M.S. Hussein, Hatch  
David Lemieux and Jean-Philippe Mai, Dundee Sustainable Technologies



588077

**Study on Selective Removal of Arsenic from Black Copper Sludge**

Zhiyong Liu, Wei Yao, and Qihou Li, Central South University



590145

**Understanding the Effect of Ore Hardness Variability on the Integration of Solar Energy into the Operation of a Semi-Autogenous Grinding Mill**

Giovanni Pamparana, Norman B. Keevil Institute of Mining Engineering, The University of British Columbia  
Willy Kracht, Department of Mining Engineering, Universidad de Chile  
Julian M. Ortiz, Queen's University  
Jannik Haas, Department of Stochastic Simulation and Safety Research for Hydrosystems (IWS/SC SimTech), University of Stuttgart, Germany



590724

**Necessity an International Scheme for Assessment on Arsenic Treatment Facilities**

Takashi Nakamura, The University of Tokyo  
Nobuo Yamazaki, Senior Analyst



592155

**Geochemical Performance of Mine Rock beneath an Elemental Sulfur Stockpile and Implications for Water Quality Management Following Removal of the Stockpile**

Shauna Litke, The University of British Columbia  
Stephen Day, SRK Consulting  
Wenyong Liu, The University of British Columbia



592292

**Separation of Arsenic and Recovery of Antimony and Tin from Silicate Slag in Nonferrous Smelter**

Etsuro Shibata and Atsushi Iizuka, Institute of Multidisciplinary Research for Advanced Materials, Tohoku University



593346

**Experimental Evaluation of Pyrometallurgical Recycling Processes for Lead Removal from Brass**

Simon Hilgendorf, Institute of Process Metallurgy and Metal Recycling (IME), RWTH Aachen / Fraunhofer Project Group Materials Recycling and Resource Strategies

Gert Homm, Carsten Gellermann, and Rudolf Stauber, Fraunhofer Project Group Materials Recycling and Resource Strategies

Bernd Friedrich, Institute of Process Metallurgy and Metal Recycling (IME), RWTH Aachen University



594017

**Environmental Emissions Management at the La Caridad Copper Smelter**

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Jose A. Puente, Metalurgica de Cobre S.A. de C.V

Matt Russell, Gas Cleaning Technologies, LLC



594356

**Air Granulation of Copper Slags for Iron Silicate Production Part 2: Drawing Parallels from Air Granulation of PGM Converter Slag**

Lily L. C. So, Hatch Ltd.

JP Janse van Rensburg, Northam Platinum Ltd.

Darryl Metcalfe, Mahdi Mahdi, and Jennifer Woloshyn, Hatch Ltd.

Nadia Uys, Northam Platinum Ltd.

Daan Sauter and Andrew MacMillan, Hatch Ltd.



594543

**Flowsheets of the Future**

Robert Matuszewicz, Outotec Pty Ltd.

Jouni Pihlasalo, Outotec Research Center

Marko Olavi. Lampi, Outotec (Finland) Oy

Ross Andrews and Jacob Wood, Outotec Pty Ltd.



594613

**Fundamental Study on the E-Scrap Recycling Technique Using Alkaline Medium**

Yu-ki Taninouchi, Naoki Saito, Akihiro Kishimoto, and Tetsuya Uda, Kyoto University



594767

**Permitting, Construction and Commissioning of a New Slag Landfill at Boliden Harjavalta**

Hanna-Leena Heikkilä and Esa J. Peuraniemi, Boliden Harjavalta



594776

**Outotec Solutions for Processing E-Scrap**

Stephen Hughes, Outotec Pty Ltd.

Mikael Jåfs, Hannu Johto, and Janne Karonen, Outotec (Finland) Oy

Jan Stål, Outotec (Sweden) AB



594790

**Metal Recovery and Environmental Loading Reduction of Copper Mine Tailing by High Pressure Leaching and SX-EW Process**

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Ljiljana Avramovic, Radojka Jonovic, and Zoran Stevanovic, MMI-Bor

Daizo Ishiyama, Atsushi Shibayama, and Yasushi Takasaki, Akita University



595026

**Process Metallurgy in Circular Economy System Design: The Copper and Base Metal Value Chain**

Alejandro Abadías Llamas, TU Bergakademie Freiberg  
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Michael Stelter, TU Bergakademie Freiberg  
Alicia Valero Delgado, CIRCE Institute  
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595056

**Hydrochloric Acid Regeneration from Hydrometallurgical Chloride Salt Wastes — A Sustainable Technology**

Maziar Sauber, CanmetMINING-NRCan  
Ahmad Ghahreman and Caitlyn McKinley, Queen's University



595223

**Strategic Scheduling of Preventive Maintenance in Copper Processing as a Flexibility Option for Highly Renewable Energy Systems**

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Tobias Junne, German Aerospace Center - Institute of Engineering Thermodynamics  
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595289

**Trends and Treatment of Arsenic in Copper Mining**

Carlos Rebolledo and Nelson Parra, Ecometales Limited



595477

**Selenate Removal from Waste Water by Direct Chemical Reduction**

David Dreisinger and Maryam Mohammadi, The University of British Columbia  
Brent Murphy, Seabridge Gold  
Jianming Lu and Berend Wassink, The University of British Columbia  
Clem Pelletier, Seabridge Gold



595701

**Designing Sustainable Prosperity - A Collaborative Effort to Build Resilience in the Copper Producing Regions**

Doris Hiam-Galvez, Hatch



597475

**Recovery of Selenium from Acid Plant Reverse Jet Scrubber Sludge in Copper Smelting**

Lakshmi Kanth Reddy Madikunta, Bhavin Desai, Chandrakala Kari, Aditya Birla Science and Technology Company Private Limited  
Sanjay Sarkar, Kaushik Vakil, and Divyang Shah, Hindalco Industries Limited (Unit: Birla Copper)



598747

**Sustainable Development and the Primary Copper Industry: Past, Present and Future**

Krishna Parameswaran, tfgMM Strategic Consulting



599348

**Urbangold Technology - The Solution for an Economical and Sustainable Recycling of Electronic Scrap**

Rolf Degel and Timm Lux, SMS group GmbH  
Stefan Konetschnik, UrbanGold GmbH  
Andreas Filzwieser, Mettop GmbH  
Hans-Jörg Krassnig, PolyMet Solutions GmbH



602638

**Desalinated Water Infrastructure Optimization under Competing Trade-Offs in the Antofagasta Mining Region of Chile**

Nadja C. Kunz, Cecilia Campero, Costanza Nicolau, and Liliana Paliero, The University of Queensland



602983

**Strategies for Patenting 'Green' Technologies**

Van Vekris, Marks &amp; Clerk Canada



603040

**Future Trend for Contribution of Solar Energy to the Mining Industry and Water Desalination**

Alexander Levrán, SUMEC NA



615521

**Process Metallurgy in Circular Economy System Design: Challenges & Solutions**

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