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Lead and Zinc Metallurgy

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The current *JOM* topic "Lead and Zinc Metallurgy" offers the readers an update about current research work and developments in the processing of these two metals. Both metals have been produced and used for thousands of years. Several well-proven pyrometallurgical and hydrometallurgical processes are used today for covering the world's demand.

Lead and zinc are the two most commonly used nonferrous metals, after aluminum and copper. They are found in a wide range of applications in everyday life in the form of metals and their compounds. Both lead and zinc are prevalent in the automotive industry. Lead is, of course, a primary component in lead-acid batteries, whereas zinc is used in galvanized steel and as an activator in the vulcanization process for tires. The two metals are closely connected, starting with their mineralogical occurrence in combined lead-zinc ores (i.e., combination of mainly lead sulfide, zinc sulfide, iron sulfide, iron carbonate, and quartz) that are processed in the primary industry and hence interlink the production routes. Both metals have very high recycling rates. In particular, lead is the most recycled metal (65%). The current trend leads to an even closer combination of primary and secondary metallurgy, as many originally primary smelters use more and more additions of secondary feed materials, creating new challenges for the process.

Both pyrometallurgical and hydrometallurgical processes are in use and are the subjects of ongoing research. The importance and widespread use of the two metals requires suitable processing technologies for primary and secondary production, comprising improvement of existing processes, development of new processes including challenging input material like low-grade or multicomponent ores, handling of process by-products, and a general focus on efficiency, economy, and environment.

Dean Gregurek and Zhiwei Peng are the guest editors for the Pyrometallurgy Committee of the TMS Extraction & Processing Division, and coordinators of the topic Lead and Zinc Metallurgy in this issue.

The following papers being published under the topic of Lead and Zinc Metallurgy provide excellent details and research on the subject. To download any of the papers, follow the URL: http://link.springer.com/journal/11837/67/9/page/1 to the table of contents page for the September 2015 issue (vol. 67, no. 9).

- "Separation of Zinc from High Iron-Bearing Zinc Calcines by Reductive Roasting and Leaching," by Ning Peng, Bing Peng, Xiaobo Min, Hui Liu, Yanchun Li, Chen Dong, and Xue Ke

Some lead and zinc ores also contain significant amounts of iron and, hence, require efficient separation technologies for metal recovery. The article by Ning Peng et al. introduces a separation process for recovering zinc from high iron-bearing zinc calcines. A combined roast-leach process, namely using gaseous roasting and acid leaching, was investigated theoretically and practically. It allowed the separation of zinc from iron without an additional iron precipitation process. Furthermore, the efficiency regarding zinc separation from iron was higher than in the case of the combination of carbothermic reduction and leaching.

- "An Efficient Technology for Smelting Low-Grade Bismuth-Lead Concentrate—Oxygen-Rich Side Blow Process," by Lin Chen, Zhandong Hao, Tianzu Yang, Hui Xiao, Weifeng Liu, Duchao Zhang, Shu Bin, and Wanda Bin

Low-grade or multicomponent ores represent special challenges in processing and suitable processes should be pursued to enable an economic and efficient metal recovery. Metal separation is especially difficult in the case of metals that exhibit very similar chemical properties and behaviors during

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metallurgical treatment. The article by Lin Chen et al. describes a new technology for smelting of low-grade bismuth-lead concentrate, using two oxygen-rich side blow furnaces (OSBFs) for the process stages of oxidative smelting of the concentrate and subsequent reductive smelting of the oxidized slag from the upstream furnace. By this smelting technology, a final bismuth content of about 0.05 wt.% in the reduced slag was achieved, which was 6–10 times lower than that of the traditional pyrometallurgical processes.

- "High Zinc Recovery from Residues by Sulfate Roasting and Water Leaching," by Ming Hu, Bing Peng, Liyuan Chai, Yanchun Li, Ning Peng, Yingzhen Yuan, and Dong Chen

Today, the main primary zinc production route is the hydrometallurgical process, namely the combination of leaching and electrowinning. The resulting respective residues still contain considerable amounts of zinc that are worth recovering. The third article introduces a combined process for zinc recovery from hydrometallurgical residues, using roasting and water leaching. The effects of various process parameters on zinc recovery rates were investigated and the optimum process conditions for zinc recovery and zinc-iron separation were determined.

- "Postmortem Study on a Magnesia-Chromite Brick Out of Lead Recycling Furnace," by Dean Gregurek, Katja Reinharter, Viktoria Reiter, Christine Wenzl, and Alfred Spanring

Refractory materials are a vital component in every pyrometallurgical process and are subjected to various wear mechanisms that influence refractory life and hence furnace performance. The fourth article provides a detailed postmortem analysis of a used silicate-bonded magnesia-chromite brick out of a lead recycling furnace. The effect of observed wear factors, namely chemical slag attack and infiltration, were examined by comprising practical results (actual wear) and theoretical thermodynamic calculations.

- "Influence of Fluoride Ion on the Performance of Pb-Ag Anode During Long-Term Galvanostatic Electrolysis," by Xiaocong Zhong, Xiaoying Yu, Liangxing Jiang, Xiaojun Lv, Fangyang Liu, Yanqing Lai, and Jie Li

Because of its good chemical resistance, lead is a common electrode material in electrolysis and battery applications. Electrode corrosion is an important factor affecting the efficiency of electrometallurgical processes. The fifth article investigates the long-term behavior of lead-silver anodes in galvanostatic electrolysis, namely chemical reactions in sulfuric acid solution. The influence of fluoride ion was studied regarding anodic potential, morphology and phase composition of the anodic layer, corrosion morphology of the metallic substrate, and anodic oxygen evolution.

- "Kinetics of Reductive Acid Leaching of Cadmium-Bearing Zinc Ferrite Mixture Using Hydrazine Sulfate," by Chun Zhang, Jianqiang Zhang, Xiaobo Min, Mi Wang, Bosheng Zhou, and Chen Shen

Leaching of multicomponent materials leads to dissolution of various components, in either a desirable or an undesirable way. Hence, it is important to understand the leaching behavior and kinetics, as well as the potential influencing parameters. In the article by Chun Zhang et al., the dissolution of cadmium, zinc, and iron from cadmium-bearing zinc-ferrite mixtures was studied and a kinetics analysis was performed.

- "Recycling of Zinc and Lead-Bearing Residues with Pyrolysis Gas," by Christoph Pichler and Juergen Antrekowitsch

Most reduction processes involve the use of carbonaceous materials that in turn creates considerable CO_2 emissions. For reducing these emissions, alternative reductants are required to improve the CO_2 balance of the process. Additionally, landfill should be reduced, i.e., the disposal of waste products by burial. The seventh article suggests a pyrometallurgical process that addresses both mentioned issues, namely the treatment of zinc- and lead-containing residues in a vertical retort, using pyrolysis gas obtained from charcoal as reductant.