

TUESDAY, AUGUST 24, 2004, P.M.

SESSION 37: FIFTH INTERNATIONAL SYMPOSIUM ON WASTE PROCESSING AND RECYCLING IN MINERAL AND METALLURGICAL INDUSTRIES

SLAG PROCESSING AND UTILIZATION

Sponsors: Hydrometallurgy, Non-Ferrous Pyrometallurgy, Iron and Steel Sections and Environment Committee of the Metallurgical Society of CIM and the Environmental Society of CIM

Room: Chedoke B

Chairmen: J. EMERY, John Emery Geotechnical Engineering Ltd., Toronto, Ontario, Canada, and D. CONOCHIE, McMaster University, Hamilton, Ontario, Canada

PAPER 37.1 — 14:00 (KEYNOTE)

TECHNOLOGY OF SLAG UTILIZATION IN CONSTRUCTION.

G. WANG and J. EMERY, John Emery Geotechnical Engineering Limited, Toronto, Ontario, Canada

Research and applied utilization activities for the increased use of ferrous and nonferrous slags in construction are presented. The overall use of blast furnace slag is relatively well known for a range of construction applications from aggregates to slag cements. In contrast to blast furnace slag, which is volumetrically stable and straightforward in its construction uses, steel slag contains hydratable oxides that can result in volumetric instability that must be dealt with through appropriate steel slag aging, testing and quality control to ensure its appropriate use. Quality requirements and guidelines on steel slag expansivity to further the use of steel slags, with demonstrated acceptable performance, are outlined. There is a full range of proven construction uses - from aggregate to cementitious materials - for copper, nickel and phosphorus nonferrous slag. The use of air-cooled nickel slag is presented, based mainly on practical highway construction experience. It has been shown that air-cooled, crushed nickel slag can be an excellent aggregate in granular base, engineered fill and hot-mix asphalt. There is a good potential for increased ground, granulated copper and nickel slags use as supplementary cementitious materials that is being developed, which takes advantage of the 'latent energy' content. The scope of a new technical text in preparation on the technology of slag utilization is reflected throughout to provide a practical context for the engineer.

PAPER 37.2 — 14:50

METAL RECOVERY FROM ZINC FUMER SLAGS.

Y. ZHANG, F. HE and T.R. MEADOWCROFT, University of British Columbia, Vancouver, British Columbia, Canada

Slag from the zinc fuming furnace contains about 3 % Zn and 0.1 % Pb. The paper outlines several experimental techniques for recovering these components from liquid fumer slag. The simplest method, remelting followed by a hold period, indicated that a substantial fraction of the metal values was recoverable as a result of fuming into the gas phase, presumably by reduction of the metal ions by divalent iron ions. Following on from this, slag samples were equilibrated with copper, chosen because the activity coefficients of zinc and lead in copper are very low. This improved metal recovery, with substantial amounts of lead and zinc reporting to the liquid copper as well as to the fume. Application of an electrical emf across the slag-metal interface, using a graphite anode and a liquid copper cathode, resulted in further gains in metal recovery. These same techniques were also applied to slags from the Kivcet-process with encouraging results. This is significant in that high levels of metal recovery from this slag could eliminate the need for slag fuming.

COFFEE BREAK — 15:15 – 15:40

PAPER 37.3 — 15:40

RECYCLE OF CONVERTER SLAG BY HIGH TEMPERATURE CARBON THERMAL REDUCTION.

G. LI, F. ZHANG, Wuhan University of Science and Technology, Wuhan, China, L. ZHANG, Z. SUI, Northeastern University, Shenyang, China, and T. OU, Wuhan Iron & Steel (Group) Co., Wuhan, China

Researches on the recovery of iron, manganese and the removal of phosphorus from converter slag were reviewed. The carbon thermal reduction experiments were carried out by induction heating the mixture of converter slag and graphite powders at 1650°C and 1800°C in a graphite crucible. It was found that 62.7% of the phosphorus in converter slag was reduced into carbon saturated iron alloy, 32.8% of that was vaporized and only 4.5% of that remained in the final product. Totally 95.5% of the phosphorus in converter slag was removed. Almost all iron and manganese was reduced to form carbon saturated alloy. It was found that the free lime in converter slag can react with carbon to form

calcium carbide at 1800°C. The main phases in the reduced converter slag are dicalcium silicate and tricalcium silicate with small amount of calcium carbide.

PAPER 37.4 — 16:05

DISSOLUTION BEHAVIOR OF NON-FERROUS SMELTER SLAG IN AQUEOUS SULPHUR DIOXIDE.

S. HOQUE and C.Q. JIA, University of Toronto, Toronto, Ontario, Canada

Smelter slags contain valuable metals such as Co, Ni and Cu in proportions of less than 1 wt % along with about 40 wt % of Fe and 15 wt % of Si. Although aqueous SO₂ is a versatile lixiviant for transition metals, dissolving the slag in aqueous SO₂ solution produces solutions in which Co and Ni concentrations are often much lower than that of Fe. To develop a strategy to raise Co/Fe and Ni/Fe ratios of the solutions, the dissolution behaviour is investigated experimentally and using OLI, software package for simulating electrolytes chemistry. The paper reports key findings and discusses their practical implications.

PAPER 37.5 — 16:30

THE TREATMENT OF WASTE SLAG CONTAINING HEXAVALENT CHROMIUM USING SINTERING METHOD.

Z-G. REN, Beijing Central Iron & Steel Research Institute, Beijing, China,

Y-G. YANG and J-S. QIAN, Fanghui Inc., Hebei, China

The waste slags from chemical and metallurgical plants contain approximately wt 1% water soluble Cr⁶⁺, which is very harmful to human health. A sintering method was developed to treat the waste slag. In this process, sinter was made from a mixture of the waste slag containing hexavalent chromium, iron concentrate and coke breeze. During sintering, hexavalent chromium was reduced to trivalent chromium. The latter is known as a non-harmful material and can be used as chromium resource for the production of ferrochromium or chromium-containing cast iron. The waste slag with fine particles was favourable for Cr⁶⁺ removal. An increase of carbon content in the sintering mixture could increase the rate of Cr⁶⁺ removal and the strength of the sinter produced. The rate of Cr⁶⁺ removal increased with increasing basicity of the sintering materials with basicity less than B=1.8, above which it decreased with increasing basicity. Blast furnace was found to operate smoothly when using the sinter made from the waste slag containing chromium. However the productivity of sintering machine was slightly low compared to the sintering operation using ordinary raw materials.

PAPER 37.6 — 16:55

UTILIZATION OF COPPER PYROMETALLURGICAL SLAGS.

O. PAVEZ, F. ROJAS, J. PALACIOS, University of Atacama, Copiapó, Chile, and

M. SANCHEZ, University of Concepción, Concepción, Chile

Copper sulfide is the main mining resources in Chile, and most of this metal is obtained via pyrometallurgical extraction in seven copper smelter plants, which extends from the northern Atacama desert to the central part of the country. In 2002, 1,522,000 metric tons of fine copper were produced, with a notorious environmental impact due to the large amount of slag generated, including transportation and disposing problems. A total project development concept is explained, which considers residues as new resources where new components could be obtained, improving sustainability in mining activities and also ensuring clean production processes. Copper slag characterization and several ways of utilization, including compact material for road and railway installation, part of admixtures in concrete are discussed.