Book reviews

Jones, M. J. (editor). *Process engineering of pyrometallurgy. Proceedings of a joint meeting of the Institution of Mining and Metallurgy and the Institution of Chemical Engineers.* London, Institution of Mining and Metallurgy, 1974. 105 pp. £6,50.

The eleven papers that were presented at the meeting deal mainly with models derived mathematically or on the basis of laboratory experiments, and each is briefly summarized below.

Formation of liquid metal droplets, by G. H. Johnston and J. B. See.

An experimental laboratory study was undertaken to gain increased understanding of the mechanism for the production of liquid-metal droplets by the disintegration of a stream of liquid metal with a subsonic gas jet. The approach to the investigation was fundamental, and the findings add another facet to knowledge on the theory of metal-powder manufacture.

L.D. Steelmaking: significance of the emulsion in carbon removal, by D. J. Price.

A plant-scale investigation was carried out to trace the mechanism of carbon removal in the basic oxygen furnace. A specially designed in-blow bomb sampling device was used in collaboration with a radioactive gold-isotope tracer technique. The findings indicate that approximately 35 per cent of the carbon was removed via the emulsified metal droplets, whose residence time in the slag was found to be $2 \pm 0{,}5$ minutes.

Model simulation of heat transfer in blast-furnace stoves, by B. Indyk.

An experimental study was undertaken on a laboratory stove set-up to simulate a blast-furnace stove. The paper describes the development of a method for the determination of the effective temperature difference between the brick and the gas, and of the heat-transfer coefficient. Easily obtained measurements are used in these calculations.

Impinging jet spray with molten lead, by M. Gammon.

Sprays formed by impinging jets of liquid were investigated by the use of water and molten lead. Heat- and mass-transfer characteristics are presented, leading to the conclusion that the jet-spray system used is suitable for the absorption of zinc vapour by lead at the gas-separation section of zinc-lead blast furnaces.

Slag washing of silver, by W. Freidl and D. G. W. Frost.

The application of elementary chemical-engineering concepts to the slag washing of silver is demonstrated in this paper. The traditional refining of silver, mainly the removal of the major impurity—copper—is done by oxidation of the copper to cuprous oxide and the separation of the slag formed. Transfer of the copper was treated as a countercurrent solvent-extraction problem, and modified McCabe-Thiele diagrams were constructed. These diagrams, which were derived from plant runs, permit the prediction of the end-point of the reaction to achieve silver of 99,9 per cent purity.

Reduction of hematite particles injected into an electrically augmented flame, by R. J. Tait and T. F. Wall.

The paper presents a model for the reduction of hematite particles by a mixture of H, H_2, and CO by a novel technique. The reducing gases are injected into a flame augmented by an electric arc. The arc increases the proportion of dissociated hydrogen in the stream, which intercepts a stream of hematite particles. The reduction to metallic iron is achieved in 0,05 second. The study represents another attempt to increase the proportion of electrical power used in pyrometallurgical processes. This will help to alleviate the future shortage of fossil fuel.

Model studies on mass transfer across a metal-slag interface stirred by bubbles, by D. C. G. Robertson and B. B. Staples.

Mass transfer across the metal-slag interface was simulated by an experimental cold-model study. Amalgam-aqueous and lead-molten salt systems were stirred by rising bubbles. This room-temperature model appears to predict, with a reasonable degree of accuracy, behaviour in a gently boiling open-hearth furnace.

Turbulent mixing in metallurgical systems, by J. Szekely, S. Asai, and C. W. Chang.

The ability to measure and predict turbulence levels and the turbulent velocity field can have significant practical applications. It is a prerequisite to a better understanding of inclusion formation, coalescence, and other mass-transfer phenomena within pyrometallurgical systems. A mathematical representation of the turbulence phenomena, based on non-linear partial differential equations, is proposed in this paper. The practical examples considered include the argon-stirred ladle and mixing in a metal pool caused by impinging gas jets. The results were found to be in good agreement with experimental model studies.

Heat transfer to a bed of melting solids, by V. Rajakumar, L. G. del Corral, A. W. D. Hills, and A. V. Bradshaw.

The heat transfer between a packed bed of melting solids and a countercurrent stream of hot gas is of fundamental importance in all shaft furnaces, i.e. blast furnaces, cupolas, and the like. Melting rate, solid-liquid temperature profiles, and other heat-transfer characteristics were studied experimentally, and a mathematical model was developed.

Multi-phase reaction systems in pyrometallurgy, by A. W. D. Hills.

The complexity of pyrometallurgical processes arises mainly from the high temperatures involved, and from the multi-phase reactions in which heat-, mass-, and momentum-transfer phenomena determine the rate of most processes. Basic-oxygen steelmaking, the bosh region, and the melting regions of the blast furnace are three of the topics discussed to illustrate the inter-relation of phases. It was hoped that the identification of the multi-phase nature of the mechanisms would allow parallels to be seen in certain pyrometallurgical processes and would contribute towards better understanding and the development of improved technologies.

Packed-bed conversion processes with non-catalytic gas-solid reaction, by G. S. G. Beveridge and M. Kawamura.

This paper deals with non-catalytic gas-solids reactions that occur by the use of packed beds. Industrial examples for this type of reaction include the roasting of sulphide ores and the reduction of metallic oxides in an agglomerated form. The paper presents a mathematical model, based on the intra-pellet mass-transfer resistance, that allows investigation of the reaction progress through the solid bed over a wide range of temperature.

Z.Y.T.

Nim reports

The following reports are available free of charge from the National Institute for Metallurgy, Private Bag 7, Auckland Park 2006.

Report No. 1656

The analysis of geological samples for trace elements by direct-reading emission spectrometry.

The experimental work is described that led to the development of a method for the determination of a number of trace elements in geological samples by use of a direct-reading spectrometer.

The technique involves the diluting of a sample in the ratio of 1 part of sample to 3 parts of a buffer consisting of graphite containing 20 per cent lithium fluoride and 0,03 per cent germanium oxide as an internal standard. The mixture is loaded into a special electrode and is excited in a d.c. arc at 12 A for 80 seconds ±2 seconds. The excitation takes place in an inert atmosphere that is provided by a 'double flow' gas-stabilizing jet. The resulting digital-voltmeter readings for the various elements are read against previously prepared calibration graphs, and the concentrations of the elements in the sample are derived.

The elements determined in the direct-reader programme are Co, Cr, Cu, Mn, Mo, Ni, Pb, Sn, V, Zn, and Zr.

A photographic spectrographic variant of the method, developed at the same time, is also described. It permits the determination of a number of trace elements not in the direct-reader programme. The coefficient of variation for the method is 10 to 15 per cent, and the accuracy is of the same order.

Report No. 1669

An assessment of the carbon-rod atomizer for the determination of silver.

The atomic-absorption determination of silver by use of the carbon-rod atomizer is found to be a much more sensitive method than that using flame. The limit of detection is considerably improved if the carbon-rod method is preceded by liquid-liquid extraction for the separation of the silver from most of its associated elements. The use of acids of high boiling point (sulphuric and phosphoric acids) in the solution for measurement improves the precision of the measurement.

Silver can be determined in the range 0,002 to 0,2 p.p.m., with a coefficient of variation of about 7 per cent. There is no interference from the elements co-extracted with silver in the separation step.

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Trans-Natal Coal Corporation Limited.
Tvl Cons. Land & Exploration Co.
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