

SPOTLIGHT

on minerals processing in the Western Cape

by C.T. O'CONNOR* and J.S.J. VAN DEVENTER†

The sixth University of Stellenbosch (US)/University of Cape Town (UCT) Minerals Processing Symposium was held at the University of Cape Town on Friday, 7th August, 1987, and was sponsored by The South African Institute of Mining and Metallurgy (SAIMM). Once again the Symposium attracted a large number of delegates from the mining, metallurgical, and chemical industries. On the previous evening, the Western Cape Branch had held its first Annual General Meeting and Annual Dinner. The latter was sponsored by Mobil Oil (SA) and was attended by over 80 people. The guest speaker was Dr H. Wagner, outgoing President of the SAIMM.

The Symposium was opened by Professor J.B. Martin, Dean of the Faculty of Engineering at the University of Cape Town.

First Session

The first paper of this session (chaired by Professor J.S.J. van Deventer) was the keynote address, which was delivered by Dr B.K. Loveday of the Anglo American Research Laboratories. Dr Loveday spoke on recent developments in the gold-mining industry, and highlighted various aspects of ore-dressing over the past few years. In his address, he covered, *inter alia*, flotation, grinding, fines separation, and recent developments in on-line analytical instruments specific to the gold-mining industry. He emphasized the economic aspects of gold mining and the significant financial advantages of even small increases in extraction efficiency.

Dr J.-P. Franzidis (UCT) presented a paper on obstacles in the flotation of South African coals and how these can be overcome. The single most-important obstacle to the production of low-ash coal by flotation of the fines smaller than 0,5 mm arising from the Witbank No. 2 seam is lack of liberation. A study had shown that even milling to 90 per cent smaller than 150 μm is not sufficient to liberate significant quantities of coal from ash-forming mineral particles. However, the flotation of coal milled to even finer sizes, e.g. 95 per cent smaller than 45 μm , gives rise to other problems, notably ash entrainment. It was found that, if the flotation were carried out in an open-top laboratory cell using froth depths of 170 to 270 mm (instead of the usual 15 or 30 mm), entrainment could be reduced drastically. The yields of coal with an ash content of 4 per cent were up to 50 per cent when only a dispersant and a frother were used. The work is continuing with a column cell operating in continuous mode.

Mr G. Anderson (UCT) discussed the actions of hydrocarbon oils in determining overall coal-flotation perfor-

mance. This was regarded as a chain of successive elementary steps including oil dispersion, oil adsorption (selectivity), and the influence of the oil on bubble size. Differences in dispersion, and hence collector availability, were small and did not dictate flotation performance. Both aliphatics and aromatics adsorbed strongly on washed coal. Adsorption of the aliphatics on unwashed coal was more limited but not detrimentally so. Both oil types were very selective towards coal, indicating that poor flotation grades were chiefly a result of poor liberation. The action of the oils in the initial elementary steps (dispersion and adsorption) did not control the flotation process. The aromatic oils out-performed the aliphatics as collectors, largely because of their inherent frothing ability, and hence their influence on bubble size with its consequent effect on froth formation and stability.

This session closed with a paper on the reverse flotation of coal by Mr P. Stonestreet (UCT). Reverse flotation of coal refers to the flotation of the ash minerals, with the cleaner coal reporting to the tailings. The motivation for the reverse flotation of coal is to circumvent the coal-entrainment problem of the normal coal-flotation process. Cationic amine surfactants had been identified as suitable ash collectors. For coal depression, which requires an ionic surfactant, it is important that the ions should be of the same sign as that of the collector, and it had therefore been proposed that the ash collector would achieve coal depression as well as ash collection. Work had been carried out on artificial feed mixtures of clean coal and gangue (to simulate perfect liberation), and the results so far had confirmed the excellent ash-collecting abilities of the quaternary amines. Coal depression had been less successful, and this would be an area of future work.

Second Session

Mr F.L.D. Cloete (US) chaired the second session, which included five papers on various aspects of flotation.

In the first paper, Mr H. Fourie (US) proposed a preliminary froth model for coal flotation. It incorporates the kinetics of transfer from the pulp into the froth and uses measurements at a zero froth height. The froth itself is characterized by the bubble diameter, lamella thickness, and froth growth rate. These values are then used to predict the coal entrainment, water recovery, and grade-recovery curves for different operating conditions.

Mr V.E. Ross (US) discussed mass-transport phenomena in flotation-column froths. A model had been developed and tested that describes the behaviour of mineral particles and water in the cleaning zone of flotation columns, the possible detachment of particles from their sites of attachment due to overloading of the bubble surface area with increasing distance from the interface between the collection and cleaning zones, and the

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rate at which particles are transported into the cleaning zone. An adequate description of the concentration-height profiles of solids and water in the froth was given.

He was followed by Mr D.J. Nieuwoudt (US), who had recently started work on factors that influence the scale-up of an air-sparged hydrocyclone. With reference to earlier work by A.J. Burger (US), he observed that this apparatus had enormous potential to intensify the flotation process, and suggested a number of strategies for future investigation. From the response of the audience, it was clear that industry was particularly interested in this work.

Professor C.T. O'Connor (UCT) presented a review paper on recent developments in column flotation. The concept of column flotation had been developed in Canada in the sixties by Don Wheeler and his co-workers. Since then, a number of plants in Canada and elsewhere had installed and successfully commissioned these cells. Recent developments in the design of these cells by the use of classical plug-flow reactor-design theory incorporating non-ideal flow parameters were presented. Properties of the froth phase were discussed, and details of the design of cells, spargers, and wash-water feed were presented.

Mr C. Goodall (UCT) presented a paper on a study of three-phase froths using a pyrite-quartz system. The study revolved around the way in which the froth parameters at different levels in the froth varied with flotation parameters. The apparatus for splitting the froth was described. The effects of different xanthate collectors on the behaviour of the froth were correlated with contact angle and hydrophobicity, and the relative importance of flotation and entrainment was noted. The system for the finding of bubble-size distribution that had been developed by Mintek was discussed. The paper concluded with a description of a column-flotation cell that is under construction at present.

Third Session

Four papers dealing with hydrometallurgy were presented during this session, which was chaired by Professor C.T. O'Connor (UCT).

The session opened with a paper by Professor G.S. Hansford, Miss D. Miller, and Mr J. Chapman (UCT) on the batch and continuous bioleaching of a gold-bearing pyrite concentrate. Batch bioleaching of a pyrite concentrate from Crown Mines had been carried out, and the propagating pore model and the empirical logistic equation had been fitted to the data. It had been found that the leaching rates per unit surface area of the pyrite were constant, leading to a means of rationalizing kinetic data on bioleaching. The logistic equation was successful in the fitting of the data obtained from the continuous leaching of the same concentrate. This provided the basis for characterizing bioleach kinetics and of predicting the performance of large-scale continuous bioleaching reactors. Bioleaching data from laboratory-scale batch tests and pilot-scale multistage continuous data on Gencor's Fairview arsenopyrite-pyrite concentrate had also been fitted successfully by the use of the logistic equation. By use of the kinetic constants from these, the performance of several cascade reactor configurations had been predicted.

In his talk on the selective leaching of base-metal

sulphides in chloride medium, Mr H.W. Scriba (US) showed that Eh could not be used as the sole controlling parameter. He illustrated that the selectivity of non-oxidative leaching is superior to that of the oxidative leaching of chalcopyrite, sphalerite, and galena. After explaining the electrochemical leaching of galena in ferric and cupric chloride, he illustrated the influence of galvanic interactions on leaching rate and selectivity.

This was followed by a paper by Mr P.F. van der Merwe (US) on the mechanism by which gold cyanide is adsorbed onto activated carbon. He explained the role of oxygen during this adsorption, and showed that the ratio of AuCN to $\text{Au}(\text{CN})_2^-$ on the carbon was not influenced by the level of dissolved oxygen, but by the nature of the active groups on the carbon. Fourier-transform infrared spectroscopy was used to illustrate that the amount of gold cyanide formed on the carbon varied for different carbons. This result corresponded to the irreversibility of the gold cyanide observed during a cyanide-free desorption test.

The final paper in this session was presented by Mr J. Zachariades (UCT) on the modelling of leaching kinetics with a view to the development of a model that can be used in a control system. Kinetic models of the 'distributed rate constant' type were of particular interest since they were useful in describing non-linear systems. Data would be collected on the leaching of manganese from pyrolusite in acidic ferrous solution, and several models would be evaluated according to their accuracy and ease of implementation.

Fourth Session

Dr J.-P. Franzidis (UCT) chaired the final session of the day.

In a stimulating presentation, Mr F.L.D. Cloete (US) summarized some of his recent projects on the theme of process intensification. He advocated the funding of progressive research in this area. The ultimate limit on plant performance was being sought through critical evaluation of current designs with the object of reducing the size of plant units by an order of magnitude. He illustrated how recent work conducted under his supervision had led to the increase of superficial velocities in distillation from 1 to 30 m/s, the decrease in residence time from 300 to 1 s for flotation in an air-sparged cyclone, and the reduction of power in a slurry mixer by a factor of 4.

The final paper was presented by Mr M.A. Reuter (US), who discussed the optimal design of flotation and gravity-separation circuits by use of linear programming. Two linear models had been used, the first producing the total flowrates between banks of separators and the circuit configuration, and the second the flowrates of mineral species. The grades and recoveries obtained closely resembled those of similar operations in industrial plants.

Closure

Mr R.D. Beck of Gold Fields of South Africa summarized the proceedings and emphasized the importance of this annual symposium in the Western Cape. A well-attended cocktail party served as a further opportunity for interaction between academia and industry. On behalf of the two universities, the authors would like to express their sincere thanks to the SAIMM for sponsoring this event once again.

Uranium and electricity

A symposium on 'Uranium and Electricity—The Complete Nuclear Fuel Cycle' will be held in Saskatoon, Canada, during 18th to 20th September, 1988. The Symposium is sponsored by the Canadian Nuclear Society.

Many developments from the electrical generation end of the nuclear-fuel cycle are applicable to the uranium mining and manufacturing industries, for example personnel radiological protection, environmental protection from low-level waste, future quality and quantity requirements for uranium.

The objective of the Symposium is to provide a forum for the uranium-mining industry to interface with the nuclear-power generation industries on a technological and personnel level to discuss topics of mutual interest and benefit.

The following topics will be covered in the Symposium:

- Uranium exploration and mining
- Uranium metallurgy, refining, and byproducts

- Environmental and personal hygiene aspects of the uranium fuel cycle
- Reactor fuel management and radioactive-waste storage and handling
- Future of the uranium industry in electricity generation.

Papers are invited on these topics. Abstracts of between 300 and 500 words should be received by 30th November, 1987. Authors of accepted abstracts will be required to submit completed manuscripts by 1st April, 1988.

Enquiries about the Symposium should be addressed to:

V.I. Lakshmanan/K.H. Talbot
Symposium on '*Uranium and Electricity—The Complete Nuclear Fuel Cycle*'
Canadian Nuclear Society
111 Elizabeth Street
Toronto, Ontario, Canada
M5A 1Q7.

Electric steel

The Institute of Metals, organizers of the 3rd European Electric Steel Congress, have announced that this important international event will take place in October 1989 at the Bournemouth International Centre.

Previously held in Aachen in 1983 and in Florence in 1986, the European Electric Steel Congress is now a well-established international event attracting in the region of 1000 delegates, including plant operators and managers, process and system designers, manufacturers of process plant, suppliers of consumable material for the industry, researchers and customers from a broad spectrum of user industries.

The programme for the 3rd Congress will consist of invited keynote papers and technical sessions covering research and development, equipment design, operation and maintenance, investment, and economics.

Planned presentations include papers on a wide range of topics based on the following subject areas:

- Arc-furnace melting

- Induction melting and stirring
- Secondary steelmaking
- Remelting processes
- Energy control
- Raw materials (including conservation and recovery)
- Metallurgical aspects associated with electric steelmaking.

The Congress will also include poster sessions and an exhibition of products and services. Social events and excursions will be arranged for accompanying persons, and the Congress will be followed by a programme of technical visits.

Further information is available from

The Conference Manager
The Institute of Metals
1 Carlton House Terrace
London SW1Y 5DB
England.
Telephone: 01-839 4071.