Spotlight
on solid-liquid separation

by JOHN FREER*

A colloquium on solid–liquid separation was held by The South African Institute of Mining and Metallurgy on 23rd September, 1982, at the State Pavilion Auditorium, Milner Park, Johannesburg, to co-incide with the Electra Mining Exhibition. It was attended by about 150 delegates.

Eight papers were presented covering

- Continuous in-line water filtration
- Belt vacuum filtration of acid-leached uranium pulps
- Continuous clarification of uranium pregnant solution
- Enhanced sedimentation
- Sludge dewatering by belt pressing, with particular reference to organic pulps
- Sludge dewatering by centrifuging, with particular reference to coal fines
- An introduction to life-cycle costing techniques.

The proceedings were opened by Professor A. N. Brown, President of the Institute. He stressed the need for higher efficiency, greater productivity, and increased production rates in order to promote growth and to counter continuously rising costs. The Institute encouraged members to write papers about their experiences and achievements as a means of exchanging information with one another and for the benefit of students. Their efforts in this direction would he wasted without questions and comments. He therefore looked forward to a lively discussion at the end of each session, the first of which would be chaired by Dave Viljoen and the second by Gene Fivaz.

In-line Self-cleaning Water Filter

Anthony Patz gave a stimulating, brief, and to-the-point address.

The filter he described is flanged straight into the pipe at any attitude and requires no civil or structural supports. A unit 2 m long is capable of treating 100 m^3 of water per hour at 1000 p.p.m. of solids greater than 30 μm in a pipeline of 350 mm diameter. No external power is required. Flow is uninterrupted at a low pressure drop, and the waste is discharged automatically and intermittently in concentrated form by a separate water flush, controlled by a unit set to operate at a predetermined pressure difference. A hundred units have been installed in South Africa in the past ten months. However, no user felt the filters had been in operation long enough to comment on their performance.

Belt Filtration of Acid-leached Uranium Pulps

John Taylor, Metallurgical Manager of the Chemwes Uranium plant, gave a well-illustrated and practical paper on the operation of the 9 by 94 m^2 vacuum belt filters installed there. Mechanical and operating problems concerned flocculation, belt tracking, cracked rubber belts, and the planetary gearboxes coupled to the hydraulic-motor filter drives.

Intermittent high soluble loss is attributed in part to variations in the particle-size distribution of the pulp being treated, which, in turn, depends upon the location in the slimes dam from which it was removed in relation to the penstock area. However, the correlation is not consistent, and a satisfactory explanation is still being sought.

Continuous Clarification of Uranium Pregnant Solutions

Here delegates had the opportunity to compare two continuous clarifiers, both open tank systems and both comparatively new in concept, differing from one another in operating principle.

Mr L. E. Kun described the hopper-clarification system developed on Anglo American plants — first for alkaline gold pregnant solutions, and more recently for acid uranium pregnant solutions. It consists of a straightforward pachuca tank into which unclarified pregnant solution, coagulated and flocculated outside the tank, is pumped from the bottom. During continuous operation, a 'floc' blanket is formed at the waist of the tank. This is kept in suspension by the solution rise of at least 5 m/h through the blanket, which then acts as a filter for the flocculated solids. Sludge is drained off through peripheral cones welded at the juncture of the conical and vertical sections of the tank, while clarified solution overflows the top. The operation must be continuous, air entrainment must be avoided, temperatures must be limited to 45°C to prevent disturbance of the 'floc' blanket, and the pH value must be maintained above 1,0. Under these conditions, unclarified pregnant solutions containing 400 to 700 p.p.m. of solids can be reduced to 25 p.p.m. of solids at rates of 7,0 to 8,5 m^3/m^2 per hour.

As a result, solvent loss from the solvent-extraction plant has been reduced significantly, the maintenance is low, and capital and operating costs have been reduced, the latter by as much as 90 per cent.

Pieter van Aswegen then described the clarification

* Gencor, P.O. Box 61356, Marshalltown, Transvaal 2107.

Some of the delegates who attended the Colloquium on Solid–Liquid Separation organized by the South African Institute of Mining and Metallurgy in September 1982.
Left to right, front: Mr D. A. Viljoen of Gold Fields, Mr C. E. Fivaz of Rand Mines and Chairman of the Institute's Technical Programme Committee — Metallurgy, and Mr J. S. Freer of Gencor.
Left to right, back: Mr R. Way of Buffelsfontein, Mr P. R. Bailey of Gencor, Mr A. de Clerck of Vaal Reefs, and Mr W. A. Gilbert of Gencor **(Photograph by courtesy of *Mining Week*)**

of uranium pregnant solution at Buffelsfontein by means of a circulator–clarifier.

The principle of operation is markedly different from that of the hopper–clarifier. It does not rely on a suspended 'floc' blanket as a filter medium for unclarified solution rising through it. Instead, it relies on the collection, by the incoming feed, of some of the settled solids from the bottom of the cone and their re-circulation up the inside of a concentric diffuser cone before they overflow its lip — below water level — to settle into the general body of solution in the tank.

In the more-concentrated 'floc' medium thereby induced in the diffuser, the fresh 'flocs' link up with recirculated 'flocs' to settle more rapidly once they are clear of the top of the diffuser. Sludge is drawn off near the bottom.

The design rate of rise of 2 m/h must be maintained, if necessary by recirculation, to avoid the bridging of accumulated solids from the walls of the tank to the outside of the diffuser.

Suspended solids in the uranium pregnant solution are reduced from 500 p.p.m. in the feed to less than 80 p.p.m. in the product. This has resulted in a drop of 75 per cent in solvent loss from the worst condition experienced in the solvent-extraction plant.

Enhanced Sedimentation

Mr Parker described the SERPAC clarifier, which was developed in France.

In contrast to in-line filtration and the open-tank clarification methods described earlier, this unit depends on normal settling. The settling capacity is enhanced by an increase in the settling surface resulting from the introduction of a number of parallel, bent, thin slats mounted in vertical frames and set at 50° within the unit. The water flow is horizontal across the unit.

The clarifier occupies a small area of floor space, and there are no moving parts. The unit is sensitive to loading, and therefore needs a timed discharge of solids. The makers claim reduced flocculant usage and low maintenance.

The clarifier has been used for inorganic solids, and has more recently been modified for settling organic matter in the pulp and paper, and food industries.

Dewatering of Sludge

Moving away from the separation of small quantities of solids from large volumes of solution, Mr Eustaccio of Maschienenfabrik Andritz in Austria and Mark Krieg representing Escher Wyss presented papers on the de-

watering of pulps and slurries of comparatively high solids content.

The Andritz wire-belt press is available in several models for different applications. All depend on placing the flocculated sludge to be dewatered on a bottom belt, where it first undergoes draining by gravity. As the belt is drawn into the machine, a second belt is applied on top of the sludge. The pair of belts is then drawn over or between a succession of rollers, which apply increasing pressure to squeeze the liquid from the cake.

The process is not effective for the filtration of leached pulps because of the inability to wash the cake in the machine. The cake would have to be repulped and subjected to second-stage filtration. The wire-belt press is more suited to the dewatering of pulp, paper, industrial, and sewage wastes.

The Escher Wyss paper dealt with improvements over twenty-five years to the design of their pusher-type centrifuge, with particular reference to the stroke length and stroke rate, which have increased the solids output in the dewatering of fine coal by a factor of 8 at an unchanged moisture content of 10 to 12 per cent. Steady feed conditions with respect to solids content and feed rate are required for optimum results in this continuously operating system.

The importance of equipment of this sort in modern coal processing is emphasized by the increasingly stringent quality requirements, as well as by the demands of the environmental protection authorities that all kinds of coal shall be completely processed.

Life-cycle Costing

Life-cycle costing is a mathematical modelling approach aimed at increasing productivity by the optimum choice of capital equipment from the available alternatives, and then optimizing the frequency and standard of its maintenance for present and predictable future conditions.

A programme has been developed that enables a microcomputer to perform the optimization based on engineering and best available cost data.

Solid–liquid separation is difficult, and will become more so because of the need to tighten up on environmental requirements. The technical aspects have been given much attention at Electra and elsewhere. The costs of plant and equipment are increasing, while the selling price of minerals is either constant or falling. In this situation, life-cycle costing becomes a very powerful tool.

Discussion

The ensuing discussion bore witness to the interest that the papers had engendered. The authors are to be congratulated for this and thanked for the efforts they made towards a stimulating colloquium.

Geostatistics

The School of Earth Sciences of Stanford University, the Centre de Geostatistique of the Paris School of Mines, and the Department de Genie Mineral of the Ecole Polytechnique of Montreal are co-sponsoring the organization of a 2nd NATO ASI (North Atlantic Treaty Organization Advanced Study Institute), under the name of 'GEOSTAT TAHOE 1983', to be held at South Lake Tahoe, California, on 4th to 17th September, 1983.

GEOSTAT TAHOE 1983 is intended as a forum for researchers and advanced practitioners of geostatistics as applied to natural resources characterization.

This forum aims toward the establishment of a state of the art including

- — major new theoretical results obtained since the last ASI, held in Rome in 1975
- — new avenues of research essential to expand both the theory and the scope of applications
- — the range of proven applications inside and outside the mining and geology field.

Morning sessions will be reserved for theoretical presentations, followed in the afternoon by discussions of corresponding practical applications and case studies.

1st Week
- Geology and Variogram Modelling
- Stationary Kriging and Cokriging
- Local and Global Estimation of Recoverable Reserves
- Models and Alternatives for Non-Linear Geostatistics
- Geostatistics of Highly Skewed Distributions
- Conditional Simulations and Applications

2nd Week
- Non-Stationary Geostatistics/Automatic Cartography
- Petroleum Geostatistics
- Hydrogeology and Soil Sciences Applications
- Geostatistics for Air Pollution Monitoring
- Geostatistics and Data Analysis Academic Teaching and Continuous Education
- Organization of the next meeting

Further information is available from GEOSTAT TAHOE 1983, Department of Applied Earth Sciences, 310 Mitchell Building, Stanford University, Stanford, California 94305, U.S.A.