

positive in the plant and 50mm columns, but the distribution of the wash water was inadequate in the plant columns at the time of the survey.

50 mm Columns vs Mechanical Cells. Since the sized behaviour of the 50 mm column is being used as a base line for the plant columns, it is necessary to explain how it compares with mechanical cells. The 50 mm column was compared with mechanical pilot plant cells at least once, in four different cases during the Hilton pilot plant testwork (prior to the commissioning of the Hilton Concentrator). Each pilot plant circuit was made-up of three closed-circuit cleaning stages using mechanical cells. Also the 50 mm column was compared with the lead and zinc cleaner block feed at the Mount Isa Lead/Zinc Concentrator. Each one is made-up of three closed-circuit stages of cleaning using mechanical cells. In all cases the column and the mechanical cells were run in parallel.

The main points from these comparisons were:

- (a) For four of the six circuits tested the sized behaviour between the two units was similar in all fractions.
- (b) For two of the circuits (lead cleaner feed for Hilton hangingwall ore in the pilot plant and zinc cleaner feed in the Lead/Zinc Concentrator) the mechanical cells had a better rejection of the coarse particles and higher recovery of fines.

The inconsistent sized behaviour of the 50 mm column on the two last streams was caused by operating this unit at bias rates higher than 0.3 cm/s, i.e. 0.4 to 0.6 cm/s. For a similar behaviour between the 50 mm column and the mechanical cells, it is recommended to operate the 50 mm column at bias rates from 0.0 to 0.3 cm/s.

SCALE-UP SITUATION

The procedure used to scale-up the five column circuits has been explained in detail in other publications (Espinosa-Gomez, R., Johnson N.W., and Finch, J.A., 1989; Espinosa-Gomez, R., and Johnson, N.W., 1989). The scale-up procedure has four steps.

- (1) Determine mineral rate constants, k , using the 50 mm column.
- (2) Estimate from theory expected mixing conditions for chosen column dimensions and throughput.
- (3) Predict expected number of columns from (1) and (2).

- (4) Check if the predicted discharge rate of solids in concentrate in (3) exceeds a maximum production rate and, if necessary, limit the discharge rate to the maximum allowable.

This procedure was followed in a conservative manner to give some extra capacity which could minimise decreases in recovery due to fluctuations in the throughput to the circuit. One example of this is the extra capacity that was built-in to the design during the calculation of the rate constants. The rate constants were calculated using the nominal residence time (i.e. without subtracting the gas volume). This gave about 20% extra capacity.

For the last two circuits commissioned, i.e. lead and zinc columns at Hilton, the maximum production rate (i.e. carrying capacity, Ca, Espinosa-Gomez et al, 1988) was calculated more conservatively, using carrying capacity values measured in the bulk lead-zinc column No. 1. For the first three circuits, Ca, expressed in $g/(min \times cm^2)$, was calculated as:

$$Ca = 0.068 \times d_{80} \times Sc \quad (1)$$

and for the two Hilton circuits as:

$$Ca = 0.035 \times d_{80} \times Sc \quad (2)$$

where d_{80} and Sc are the 80% passing size in the concentrate (microns), and concentrate solids density (g/cm^3). New data on Ca from the Hilton columns also support the use of equation 2. Equation 1 was derived from columns of less than 1.1 m diameter, and particularly from 50 mm diameter columns.

In all column circuits this procedure has been successful. However, due to its infancy, it is acknowledged that the procedure can be improved by including new observations. These new observations come from experiences in running the five column circuits and analysing their behaviour in detail. This section explains these new observations.

Lower Flotation Rate Constant in Plant Columns

The rate constant (k) for the valuable mineral is a key parameter for a proper scale-up, and ideally the value measured in the 50 mm column should be the k value likely to exist in the future plant column. However, the values in the plant columns are lower, at similar air addition and bias rates. Therefore, the 50 mm column must be run at conditions which generate rate constant values as close as possible to the values in a plant column installation. There are also some operating problems which can contribute to a rate constant which is unnecessarily low