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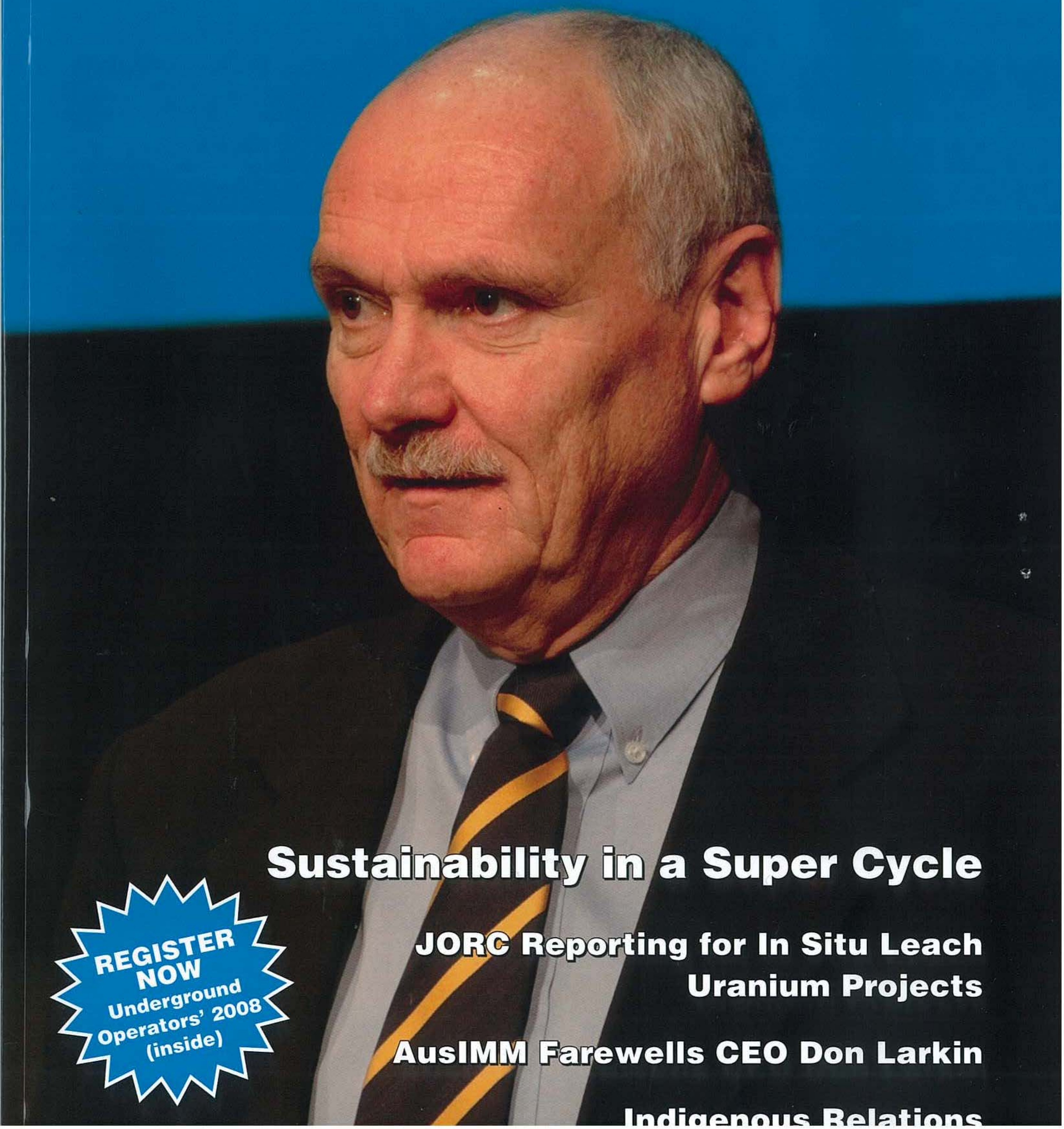

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Concentrating Minerals and Improving Energy Efficiency – A New Approach

by Brenton Burford, Senior IP Coordinator, Xstrata Technology, MAusIMM

Concentrators play a pivotal role in determining the energy efficiency of producing metal from an orebody. Concentrator design needs to maximise metal recovery from the resource, while also producing a suitable product for downstream processing, and at the lowest capital and operating cost. Concentrators use a lot of energy, especially for grinding, but they also have a big influence on the downstream energy used in smelting or refining of the products.

Frequently, concentrator design is based on the mineralogy of the valuable mineral, rather than the gangue. That is, flotation feed grind size is determined primarily by the grainsize of the target mineral, with only a small amount of regrinding done within the flotation circuit. But does the plant really need to grind the whole feed this fine? Can it grind the feed coarser, and regrind the much smaller tonnage of rougher concentrate finer? If so, significant energy savings are possible.

A different approach is to look at gangue liberation, not valuable mineral liberation, in rougher feed. That is, what grind size liberates enough gangue for rougher recovery – even though much of the recovery will be in composite particles. Once recovered, the much smaller rougher concentrate stream can be reground finer to achieve mineral liberation. To put it simply, consider gangue liberation for roughing; consider mineral liberation for cleaning. This approach can result in plants that use less energy, and make higher grade concentrates. Coarsening primary grind size also improves tailings handling, and higher grade concentrates can have significant benefits on energy use in smelting, leaching and refining.

These principles are well understood, yet concentrators are often still designed with most of the grinding capacity on rougher feed, with regrinding only used on minor streams like cleaner tails and scavenger concentrate. But this means regrinding is applied only after most concentrate has already been produced. Many composites in rougher concentrate will report directly to concentrate without 'seeing' the regrind mill. Simply, you can't get a big impact by regrinding a minor stream. If there are simple composites in final concentrate, then more regrinding of cleaner feed is needed.

One reason plant operators avoid regrinding cleaner feed is because they don't want to risk harming the whole cleaner feed. With traditional ball or Tower Mills, regrinding is often a case of "two steps forward from liberation, but one (or two) steps backward for flotation", due to:

- The effect of steel media on flotation chemistry – e.g. ferric coatings on mineral surfaces;
- High reagent needs after steel regrinding. This increases cost and reduces selectivity;
- Poorer selectivity results in high recirculating loads, which means more flotation cells, and more spillage; and
- Poor size distribution, overgrinding ('sliming'), and difficult classification of fine streams.

New technology has overcome all of these issues. The development of efficient, inert regrinding technology like the IsaMill™ changes the way circuits can be designed. Cleaner feed can be reground to produce a sharp size distribution with good flotation chemistry – this enables both coarser primary grinding, and production of higher grade concentrates.

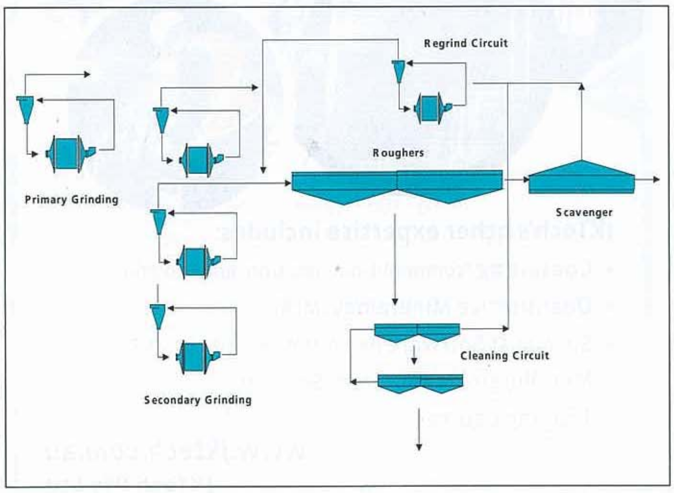


Fig. 1. Traditional circuit design with grinding of all particles based on the valuable mineral at the front end, and small inefficient grinding of complex particles at the back of the circuit

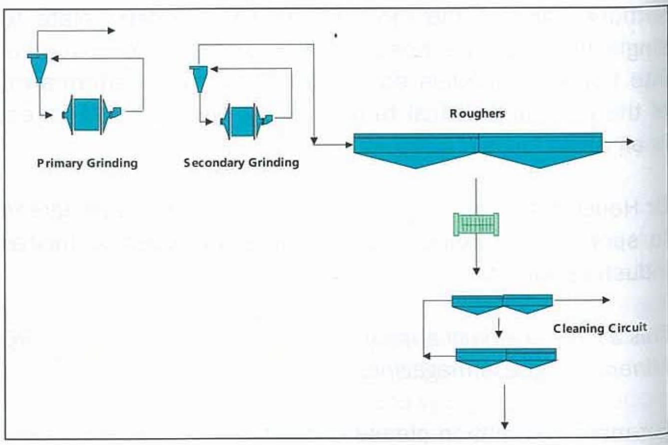
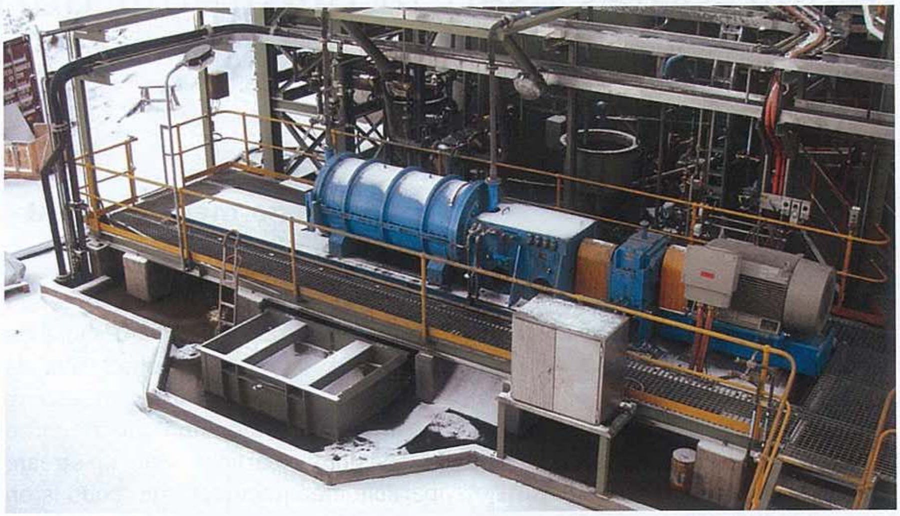


Fig. 2. Grinding only to liberate the gangue in the primary circuit, followed by grinding of all the rougher concentrate with an IsaMill™. Recirculating loads are eliminated because the minerals are ground to the right size in the right place the first time, and because flotation selectivity is not harmed by regrinding

The IsaMill™ was originally developed to improve the energy efficiency and chemistry of ultra fine grinding (less than 10 micron). It has been successful in this application, and has enabled several orebodies to be developed, including McArthur River in the Northern Territory. Yet it now appears that its biggest contribution to the industry will be improving the energy efficiency of conventional concentrators. Coarse grinding was enabled by the development of large scale (3MW) mills, and the high efficiency ceramic media for coarse grinding. As a result, the clear advantages in fine grinding are now apparent for conventional grinds:



A M1000 IsaMill™, smallest of the IsaMill™ range, powered by a 500 Kw motor (OceanaGold, New Zealand). The small size and simple installation of the IsaMill™ makes them easy to retrofit into existing flotation circuit as well as new circuits.

- High energy efficiency due to the use of economic small grinding media (eg 3.5 mm ceramic to grind 120 micron feed size)
- Sharp size distribution in open circuit due to the internal classifier.
- Small footprint – the 3 MW mill has a grinding chamber of 10 m^3, and uses 7 m^3 of media added by a simple screw feeder; and no closed-circuit cyclones. This means it can be physically located throughout the circuit wherever liberation is required.

- Crucially for circuit design, the high intensity inert grinding produces clean surfaces for flotation. This vastly improves selectivity, flotation rates, and reduces reagent consumptions, compared with conventional steel regrinding.

This has a profound impact on circuit design – it can transform a circuit from Figure 1 to Figure 2. It means the cleaner feed can be reground to the right liberation size without harming cleaner recovery. This can mean higher concentrate grade by eliminating simple fast floating composites – this can have significant energy benefits to downstream processing. Because cleaner feed is reground, rougher feed size can be coarsened without the extra composites affecting concentrate grade – with reduced capital and energy needs for primary grinding. In flotation, circulating loads can be almost eliminated – grinding cleaner feed to the right size with the right chemistry means there is no need for cleaner tails back to regrinding and roughing. Frequently circuits like Figure 1 generate over 100% circulating loads – which consume half the flotation capacity. Eliminating the circulating load would halve the amount of flotation cells, saving capital, energy, spillage and reagents.

Story based on presentation by Joe Pease, Xstrata Technology, at Crushing and Grinding 2007, Brisbane, IRR (full presentation on www.isamill.com) ■