Economics dictate change must come for mineral processing

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by Laura Syrett

Industry cannot afford to destroy value by using outdated technology, say experts

Mounting economic and practical challenges in mining are set to force wholesale changes in mineral processing solutions, delegates at the Physical Separation 13 conference in Falmouth, UK, heard last week.

Among the chief pressures faced by the extractive industry are the large amounts of capital and energy required for a mining operation, low ore grades, the problem of waste disposal, water availability, and the impact of certain gangue materials, such as sticky clays, on processing efficiency.

Delegates heard that traditional methods of processing, such as grinding, were ill-suited to the grades of ore they were now being required to process and were, in some instances, destroying the value of deposits.

Given this situation, investment is needed in more sophisticated technology that is capable of yielding more profitable returns.

“Economics dictate that change must come,” said David Bowman, study manager at the Australian mining consulting firm, Bear Rock Solutions.

Robert Morrison, chief technologist at Julius Kruttschnitt Mineral Centre, University of Queensland, said that some persistent underlying problems that miners could no longer ignore were driving engineers to develop processing systems that were significantly more advanced, but also more expensive, than the industry was used to seeing.

“This is a good thing,” Morrison said, adding that the need for investment in processing technology was imperative, since there were no signs that things would improve on the exploration front.

Falling ore grades mean more waste

The gradual decline in ore grades and increasing complexity of ore body extraction, coupled with fewer discoveries of new mineral deposits are not new challenges for the mining industry, Bowman said.
“The grandfather ore bodies are starting to get a bit long in the tooth, and processing engineers are being tasked with finding ways of squeezing the last drops of value out of both old existing and new lower grade mines,” he noted.

Bowman said that the anecdotal view of many in the industry is that the ore bodies that are still in the ground have been known for a long time, and are still there for good reason, namely that they are deemed too difficult or costly to extract.

The reliance on engineering capital to undertake the full extraction of valuable minerals contained in ore bodies is based on a traditional view of mineral extraction and tailings generation, Bowman said.

“But, given the amount of extra waste associated with processing low-grade ores, we now need to critically re-consider the flow sheets mining companies have been using for decades,” he added.

Input costs could be considerably reduced, Bowman suggested, if miners invested in more efficient methods of handling waste.

He advocated a multi-step waste rejection model, whereby unwanted rock is ejected from the processing stream at several stages, resulting in less waste being carried forward throughout the process, which would lower energy consumption.

“Adopting this view of waste handling represents a huge overall change for most mining systems, but it is an area that needs to be addressed if miners are to be successful in tackling today’s challenges,” Bowman said.

**The problem of clays**

According to John Clout, an independent iron ore specialist based in Perth, Western Australia, one of the biggest obstacles to efficient mineral processing in Australia, India and West Africa is dealing with run of mine (ROM – mined ore of a size that can be processed without further crushing), containing damp sticky clays.

Damp clays can have a devastating effect on materials handling in dry process plants. Adverse effects include blinding of screens, blocking of chutes, accretion on crusher liners leading to an overall dramatic reduction in throughput rates, damage to cone crushers and increase in plant down time.

Low grade hematite-goethite iron ores containing abundant fine clay and quartz gangue have proved particularly difficult to upgrade when using traditional wet spiral beneficiation technology, Clout said.

Wet processing is an increasingly important means of upgrading low grade iron ores in the Pilbara region of Western Australia, and is used by a number of large mining
companies including Rio Tinto at its Mesa J and Yandicoogina mines, and Fortescue Metals at its Cloudbreak and Christmas Creek iron ore deposits.

However, wet processing has received little recognition compared to the larger numbers of high grade dry crushing and screening plants, which are commonly used in iron ore processing, according to Clout.

The problem with wet processing is that very fine (<10 microns) clay-rich slimes simply follow the water used in the spiral separators to split the target mineral from the gangue.

Because the clays remain with the target mineral through to the latter stages of the processing stream, they often impede subsequent processing performance by choking and damaging parts of the separation equipment.

These problems had proved so disruptive to beneficiation that they had caused Rio Tinto to abandon some of its iron ore projects in the Pilbara, Clout said.

Clout told delegates that experiments were being conducted into flowsheets involving classifiers with two or three ‘product up-currents’.

The method employed by these classifiers is referred to as the ‘desanding’ process, which works by upgrading smaller fines to sizes that can be more easily recovered, and rejecting clay-rich ultrafines and low density sand-size gangue as tailings.

By treating clay-rich ores in this way, these classifiers are able to provide a closely sized and deslimed feed for subsequent spiral concentration, thus improving the recovery and reducing the damage to processing machinery.

Clout said that results of experiments completed to date had provided evidence that this technique could be used successfully to upgrade iron ore associated with clay-rich slimes. “But more work needs to be done, and investment needs to be made in this type of processing,” he added.

German nuclear decommissioning offers processing opportunities

Away from mining, delegates learned that Germany’s decision to phase out nuclear energy by 2022 represents an opportunity for mineral processing engineers, according to a leading German university.

The Karlsruhe Institute of Technology, (KIT) based in Karlsruhe, Germany, is conducting research into physical separation techniques that it hopes will improve technology used to break down radioactive waste from the decommissioning of nuclear power plants.

"During the decommissioning of a nuclear facility, the dismantling and disposal of the reactor pressure vessel represents a major challenge, due to the years of exposure the vessel has had to ionising radiation,” said Martin Brandauer, a researcher at KIT.
Germany has 17 nuclear reactors, which had been slated to have their life-spans extended until 2036, but are now due to be decommissioned over the next few years after the country’s government decided to reverse its nuclear policy following the Fukushima nuclear disaster in Japan in March 2011.

Brandauer explained that the reactor pressure vessel and its internal components have to be cut into small pieces to allow for their disposal in a nuclear repository. This has to be done using a technique known as water abrasive suspension cutting.

The main drawback of this process is that it generates large amounts, sometimes tonnes, of secondary waste due to the addition of a silicate abrasive, which prevents contact between the reactor and the cutting tool, that has to be discarded once used.

The abrasive used in the cutting process consists of a mixture of steel chips, garnets and other natural silicates. Once it has been used to cut sections of a nuclear reactor, the steel chips are contaminated with radiation, and therefore have to be specially disposed of as radioactive waste.

In order to reduce this secondary waste, KIT is working on a physical separation technique that will allow the radioactive particles to be separated out of the original abrasive. The particles can then be decontaminated through further reprocessing.

A separate team at KIT is working alongside Bandauer’s group to create a concrete mixture that can absorb the remaining abrasive particles, which can then be stored in KONRAD containers, a type of standardised vessel used for the final storage of radioactive waste.

“By developing this process, we aim to reduce, or even eliminate secondary radioactive waste produced from nuclear decommissioning,” Brandauer explained.

“Our results have so far been encouraging that physical separation can be used for this purpose, and provide a basis for further planned physical separation experiments,” he added.

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