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PROCESSING by Peter Caulfield

Perfecting the grind

IsaMill improves metal recovery at Anglo Platinum mines

Courtesy of Anglo Platinum Limited

Two 10,000-litre volume IsaMills located at the Mogalakwena Mine in South Africa.

As the difficulty for accessing mineral deposits around the globe continues to grow, so does the need for more efficient and cost-effective processing technologies. In response, Xstrata Technology markets the high-intensity, low-energy usage IsaMill. The milling technology, developed in the 1990s by an Australian mine operator, was initially designed to enable an ultrafine regrind to allow the economic recovery of minerals that in the past were largely lost.

The horizontally configured mill combines high performance with low-energy requirements and grinding media costs, according to Xstrata Technology, which owns the commercial rights for the mill and assists in its technical development. The IsaMill can be used for mainstream grinding, and fine and ultra-fine regrinding of concentrates. The mill can be used in all processing applications, including base metals, platinum group metals, iron ore, industrial metals and gold.

Greg Rasmussen, mineral processing process manager at Xstrata Technology, says recent developments in the mining industry are helping to stimulate demand for the mill. "As the primary mineral deposits around the world are depleted, new and more difficult deposits must be mined," he says."It is more difficult and more expensive to process these ores and to separate the minerals in them. Mine operators are looking for processing technologies that are efficient and cost-effective."

In addition to new projects, existing operations are looking to maximize the economic returns from their deposits. "The valuable minerals are usually fine-grained but not always distributed uniformly through the rest of the ore," explains Rasmussen. "New ways of thinking and new technologies, such as the IsaMill, are needed in order to deal with them."

A very fine grind

The IsaMill is a closed, horizontally configured mill that consists of eight consecutive grinding chambers and a product separator at the end. Slurry enters the feed end of the mill and travels in a plug flow pattern through the IsaMill. Fine ceramic media grinds the coarser material in the slurry. "This breakage mode produces very fine-sized particles as targeted at relatively low power consumptions," says Rasmussen.

At the discharge end of the IsaMill, the fines, slurry and grinding media reach the product separator. As a result of the centrifugal action, the fines discharge out of the centre of the product separator as the final product. The product is then piped to a discharge pump box where it is pumped to the next stage of processing, which is usually flotation or leaching. With the centrifugal action, the grinding media, along with the coarser material, is separated and pumped back into the IsaMill.

Rasmussen says the ceramic grinding media contributes to the energy efficiency of the mill. He explains that the ceramic media are more efficient at grinding due to the finer media sizing (two to seven millimetres) and that transfers the energy into the rock instead of absorbing it in the media. "The IsaMill is running at tip speeds of up to 22 metres per second," Rasmussen says. "Due to the centrifugal forces, the fine slurry is quickly separated from the coarser material as it enters the IsaMill and is discharged without coming into contact with the grinding media. This avoids over-grinding. Grinding energy is directed to the coarse particles and is not wasted on the fines. That is one of the keys to its energy efficiency."

Rasmussen adds that the IsaMill has been shown to be at least 30 per cent more energy efficient than tower mills, which, in turn, are 30 per cent more efficient than ball mills. In addition, the IsaMill performs at a higher power intensity, or energy per volume, than other mills. "The IsaMill's power intensity is 300 kW/m^3, while our competition's is only 40 kW/m^3," Rasmussen says.

IsaMill in Africa

To date, Xstrata Technology has installed 90 IsaMills around the world. One of its customers is Anglo Platinum Limited, the largest platinum producer in the world. Anglo Platinum operates mines on the Bushveld Complex in South Africa and on the Great Dyke ore body in Zimbabwe.

Chris Rule, Anglo Platinum's head of concentrator technology, says the company has installed 22 IsaMills at nine platinum group metal (PGM) mine sites. He says the company installed the mills in order to improve the liberation of PGMs for downstream recovery by flotation and also to improve the concentrate grade for smelting.

"We installed the world's first 10,000-litre capacity machine in 2003," Rule says. "We installed another mill in 2006, four more in 2007 and 16 more in 2009. In next five years, we could install another 10 machines." He says the main benefit has been the improved metal recovery. "In 2010, there was a step-change improvement at sites that have optimized the application of mainstream tertiary inert grinding," Rule explains. "The ores being milled industry-wide are generally lower grade and more difficult to process for high extractions of PGMs. Both time and this technology have allowed this negative trend to be reversed with improved metals recovery. It has added significant metal revenues at high operating margins at each site due to improved PGM recovery." CIM

Evolution of the IsaMill

The origins of the IsaMill date back to the 1970s, when Mount Isa Mines Limited in Australia was searching for methods of increasing mineral liberation by grinding concentrates to fine sizes. The company found that the performance of conventional ball and tower mills was uneconomical for concentrate particles below 25 microns, due to high energy consumption and poor results.

In the 1980s, operators at Mount Isa began to look for inspiration from other industries that grind fine particles, such as pigments, pharmaceuticals and chocolate. Although the mills used in those industries are much smaller in capacity than the full-scale ones used in mining, they use fine media moving at high speed to grind particles finely and efficiently. In 1991, Mount Isa successfully tested a bench-scale mill made in Germany by NETZSCH-Feinmahltechnik GmbH. It was followed in 1992 by a pilot-scale mill that showed that high-speed horizontal mills could efficiently grind to seven microns at laboratory scale. By 1994, a full-scale, fine-grinding production model was installed in the Mount Isa plant.

In 1998, the IsaMill was launched commercially by MIM Process Technologies (acquired by Xstrata in 2003) as a cost-effective means for the metalliferous industry to grind down to and below 10 microns. Following the development and commercialization of the fine-grind IsaMill, Xstrata Technology looked at applying the same technology to coarser mainstream grinding. Working with NETZSCH, it developed a 3MW M10,000 IsaMill. Magotteaux, a global supplier of grinding media, developed a low-cost ceramic media specifically for the IsaMill. Since 2003, the 3MW M10,000 has been the most commonly installed IsaMill.