Changing concentrator concerns

Companies are having to develop new mining technologies to deal with the scarcity of resources as well as sustainability issues. Mineral processing equipment, including concentrators, is one of the areas where OEMs need to keep up with these trends, finds Jax Jacobsen

There are few sectors within the mining industry which have not experienced their share of disruption and forced changes – from scoping to prospecting to managing waste to building relations with local communities, companies and other organisations have had to adopt new methods and approaches. But one sector – that of process design and concentrators – seemed to be relatively immune from these demands, until recently.

Concentrators needed to adapt to two pressing trends: resource scarcity and demands for greater sustainability in the industry.

The concentrator field hasn't seen any major changes in the past 15 years or so, Andrew Gillis, Sepro Systems' vice president for project management, marketing, research & development and intellectual property, tells *Mining Magazine*.

"Mining is not an industry that really loves innovation," Gillis says. "There is a bit of standing up and getting punched in the face when trying to introduce new technology…it's often easiest to do nothing."

He also acknowledges that mining companies facing a multitude of risks – whether geological, geopolitical or financial – were hardly jumping to add technology risk to their portfolio.

But the industry appears to be coming around, as it recognises the benefits of better technology and more efficient systems.

"People are making a lot more noise about innovation in the last two to three years," Gillis says. "There's an understanding that the industry wants to be perceived as more innovative so they can get a social licence, to keep building mines and to get projects in operation."

> "The concentrator field hasn't seen any major changes in the past 15 years or so"

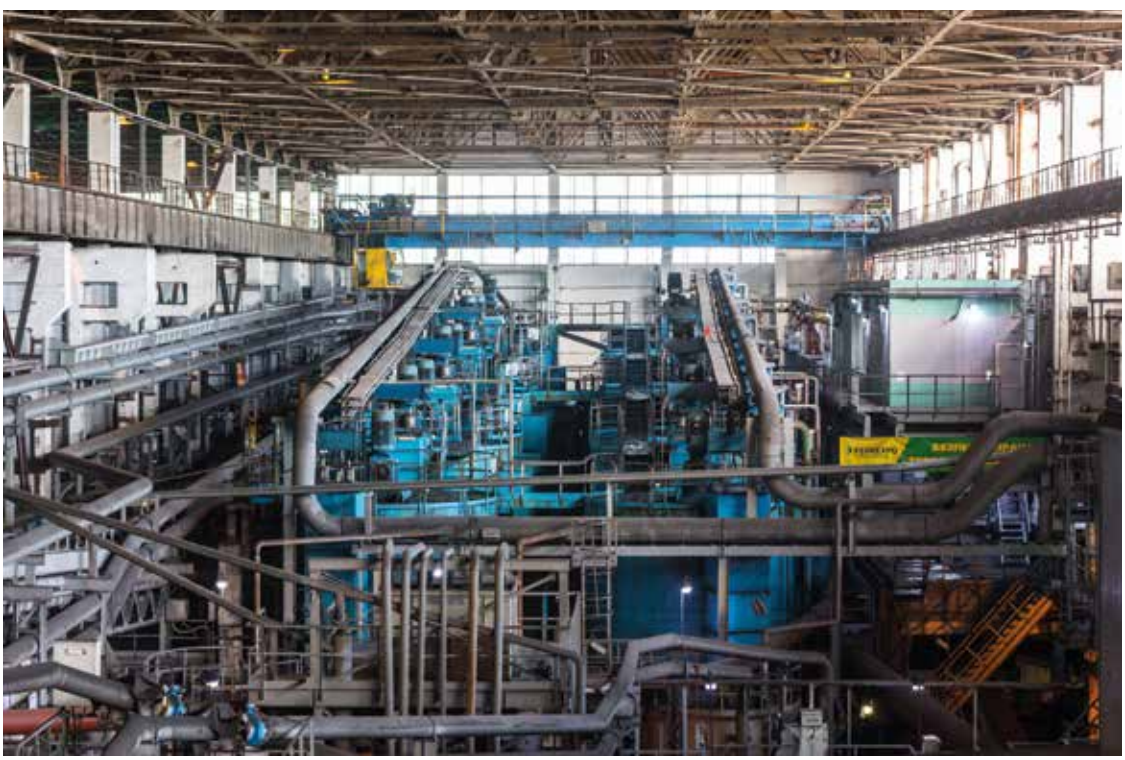
RESOURCES AREN'T AS EASY TO FIND

There are a finite number of resources on the planet, and mining companies have just about exhausted all the easy-to-reach deposits.

The unexploited resources which remain are often in remote geographical areas, with targeted metals accessible in ever-smaller quantities.

"If we have gold of 1mm or 5mm, it's super-easy to recover that with basic technology," Gillis notes. "But for gold particles of 100µm, 10µm, it's extremely difficult to recover using low-G [force]."

Two concentrators that are widely used in the industry are Sepro's Falcon concentrator and FLSmidth's Knelson concentrator. The Falcon concentrator's strength is in gold recovery for fine (below 50µm) and ultra-fine (below 20µm) particles, with a focus on tin, tantalum and tungsten. The Knelson concentrator can recover particle sizes ranging from 10µm to 6mm, and is used to recover gold, copper, silver and diamond indicator minerals.



Metso installed a pilot plant for Poltava Mining

The limited availability of metals and minerals also means that mining companies need processing systems which can squeeze as much out of previously processed orebodies as is technologically possible.

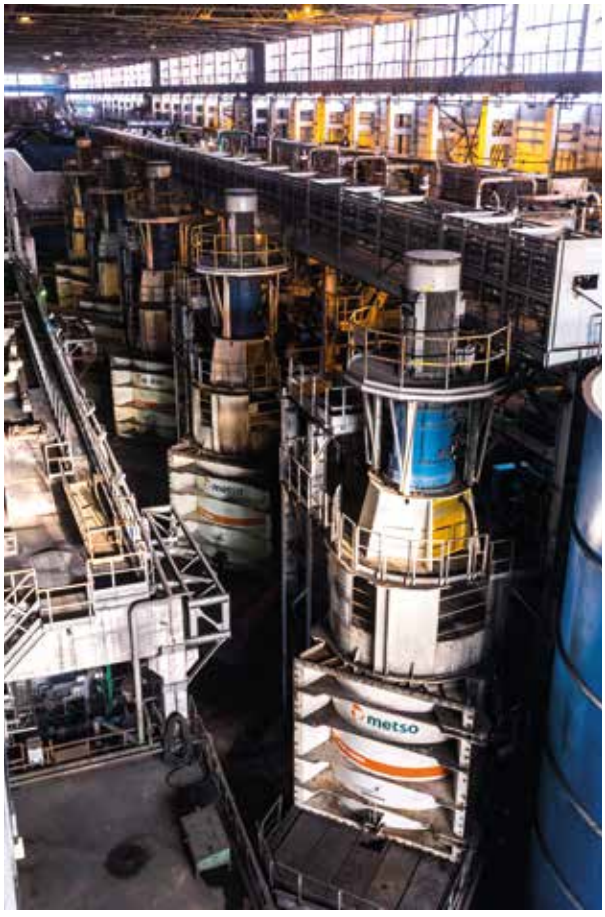
"In heavy metals and minerals there has always been a strong focus on recovering currently or previously lost values, maximising the recovery from a given deposit," says Jonas Boehnke, a process engineer with Sepro Systems.

"That means either adding the technology to an operating plant or reprocessing tailings from old dumps and ponds," he explains – which has required technological innovation.

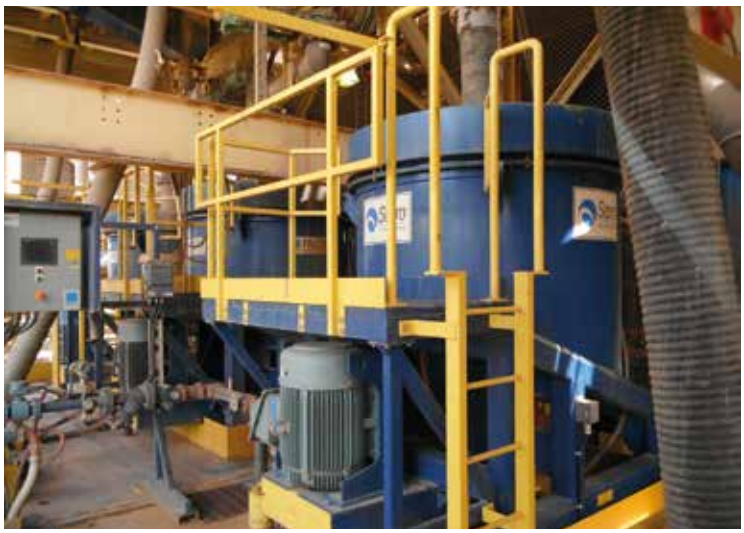
"We now better understand how to prepare the feed slurries (i.e. strict protection screening and consistent feed preparation/metering)," Boehnke says, pointing to the launch of the Falcon UF in the early 2000s, which was the first concentrator to commercialise a unit for ultra-fine application.

"The utilisation of these machines has increased recovery from probably 50% in some early installations to an estimated >95% nowadays, and that means that they can reliably work in

"Mining companies need processing systems which can squeeze as much out of previously processed orebodies as is technologically possible"



Metso has recently unveiled new modifications to its Vertimill vertical processing technologies



Sepro's Falcon SB gravity concentrator minimises water usage

conjunction with an existing plant or in stand-alone tailings reprocessing plants."

By becoming more versatile and using a wider range of G-forces and feed slurries, Boehnke suggests, it is now possible to recover metals that could previously not be recovered.

Previously, only gold could be recovered using these technologies. Now, the C and UF series can be used on multiple ore types.

"We probably put less than 10 Falcon C and UF machines in production annually before 2016, compared to approximately 50 machines in five different operations – tin, tungsten, chromite, gold – in 2018," Boehnke says.

Innovation has been happening in the iron ore space as well. Processing of these ores faces particular challenges, considering the soft nature of some ores as well as the high silica content. However, Finnish industrial machinery firm Metso has recently unveiled new modifications to its Vertimill vertical processing technologies.

In 2005, Metso installed a pilot plant for Ukraine-focused Poltava Mining, equipped with not only laboratory mills, but also with hydrocyclones, magnetic separators and flotation cells. This allowed Poltava to recover between 85% to 89% of grade less than 44µm.

"Vertimill machines help to bring up the fineness of grinding, so up to 90% of ground materials are minus 33µm," Vladimir Khovanets, the chief concentrating engineer at Poltava, explains.

In 2014, two additional flotation cells were commissioned, increasing recovery rates from 62% to 65%.

The benefits are seen not just in the recovery rates, but also in the reduction of the amount of space available for this machinery.

"A conventional drum mill operates in the horizontal position, while Vertimill is installed vertically," Khovanets says. "The space needed [for] such equipment is much smaller, and it provides a proper crushing grade."

While concentrator engineers work around the challenges of limited natural resources, they must also contend with the decreased number of skilled workers in the industry.

The recent supercycle meant there were a lot of talented engineers and researchers who have left the industry, according to Michael Lefler, global product director at FLSmidth.

"Now in the industry as a whole, a lot of talent left, and it's not coming back," Lefler says. "With US unemployment so low, getting people back [to the industry] is a significant challenge."

For this reason, FLSmidth, which produces the Knelson concentrator, is focusing on automation in its new products, taking advantage of miners' new openness to digitisation.

"The industry is changing, and they're realising slowly that having a bit more technology is good," Lefler comments. "Mines are becoming more and more high-tech and automated, and mining companies are demanding that more than they used to."

Digitisation has also been applied to process simulator training systems like Outotec's Virtual Experience Training (VEX), according to Outotec's director of process technologies Subhashis Ghosh, as a means of overcoming the exodus of skilled staff.

Fewer and fewer students are studying minerals processing and metallurgical engineering, which has contributed to the dearth of capable individuals working on processing technologies in the mining sector, Ghosh notes.

"Process simulator-based training systems have been developed and used successfully to bring up the minerals processing skills for people who lack the operational experience," Ghosh says. "Simulation-based systems provide the mining companies with a safe and cost-efficient way to build the basic skills for operating equipment and metallurgical processes."

Outotec's VEX has been used in several greenfield and brownfield projects, and offers a way to streamline operational processes across projects.

PUSH FOR ENVIRONMENTALLY FRIENDLY TECHNOLOGY

Resource scarcity is not the only challenge that needs to be overcome in order for the mining sector to flourish; also on the critical to-do list is improving sustainability in the industry.

The optimisation of concentrators and process design is focusing on two angles: reducing energy input, and reducing water used during the process.

Improvements in processing have relied heavily on increasing the amount of energy input into systems to achieve desired results. Forty years ago, low-energy centrifuges were very ineffective at separating ore from minerals and metals by creating maybe 10-15 times the force of gravity, Gillis explains.

Then came the 'second generation' of concentrators with the introduction of the Falcon concentrator, using 50 to 60-G. Now concentrators are on the third generation, relying on as much as 300 times the force of gravity.

For this reason, Gillis says, the bulk of research in the concentrator and process space has been focused on reducing energy input but maintaining or even improving recovery rates. The industry needs to adopt more energy-saving technology for two reasons: to reduce carbon emissions and to reduce costs.

Sepro engineer Boehnke acknowledges that, for the moment, improving recovery rates while decreasing energy input is not yet possible.

The other challenge is in minimising water usage during the processing stage, given the mining

"For the moment, improving recovery rates while decreasing energy input is not yet possible"

industry's reputation for being a tremendous consumer of water.

For the moment, the Falcon SB gravity concentrator consumes approximately half of the clean water than the Knelson KC concentrator series does, using an estimated 0.1m^3 of water per tonne of ore processed, Boehnke says, and research is being undertaken to lower this intake.

"We are making advancements on eliminating the need for clean water from the SB series entirely, which requires a complete re-design and which will make it the only water-less high-speed semi-batch conductor in the market, while the Falcon C and UF series do not require additional clean water, as only a small amount of ordinary process water is required for rinsing," Boehnke tells *MM*.

Meanwhile at Outotec, engineers are focused on improving new technologies such as coarse flotation and dry comminution, Ghosh notes.

Maintaining high recovery rates will still require water intake for the time being, Sepro's Gillis says. "We're really trying to pull the levers hard on water reduction," he adds. "There are R&D projects in the pipelines to reduce water [input] while improving recovery."

But Gillis is optimistic that breakthroughs will come in both the energy and water conundrums.

"If we're able to come up with devices that don't need water for processing, that we can effectively process while dry, that's a trend that's very much an interest to the industry, and we've got ideas around it," he says.

"As for energy reduction, if some way we can break that gravity concentration law that the more energy you put into the system, the better results you get – if we can break that formula, we can reduce energy and increase recovery and efficiency."

One possible way to make the processing stage more environmentally friendly is to substantially downgrade machinery in size or to use a different process, Giller suggests, by adopting the small-scale versions of concentrators that are favoured by artisanal miners in developing countries.

"These [smaller-scale] concentrators leave a dramatically smaller environmental footprint, they have a much higher level of safety because they don't use materials like cyanide," he says. "Also, gravity concentrators – these also fit into a benign category and have a low environmental impact."

"One possible way to make the processing stage more environmentally friendly is to substantially downgrade machinery in size"

Sepro's Falcon C gravity concentrator is capable of collecting fine minerals that would be missed by dense medium separators, spirals and other low G processes