Electro Overband Magnets at a Russian coal operation

Exploiting differences

Paul Moore homes in on developments & available solutions in some of the core technology areas used in mineral separation with a focus on magnetic and gravity methods

Separation in mining is a broad church and includes equipment using technologies based on magnetic, gravity and density methods, which have a vast range of applications from gold processing to iron ore, coal and other minerals such as tin ores and mineral sands but also non-metallic industrial minerals. It includes a lot of very specific solutions for very specific problems, with each niche often involving only a few potential suppliers and technology designs. As in the rest of the industry, a lot of current focus is on reduced use of water and energy but also recovering what was previously regarded as waste.

Starting with magnetic methods, whether protecting processing equipment or enhancing mineral purity, magnetic separation plays a key role in many mining and mineral processing operations. **Bunting** is one of the world's leading designers and manufacturers of magnetic separators for the mining and mineral processing industries with European manufacturing facilities in the UK.

Magnetic separators utilise either permanent magnets or electromagnetic coils to generate magnetic fields and are used to either remove costly and damaging tramp iron or for mineral beneficiation. Tramp iron occurs in the form of steel nuts and bolts, pit props, and even blasting caps, damaging crushers, screens and conveyors. Removal commonly occurs early in the process, before the primary and secondary crushers and screens.

Bunting told ***IM***: "The three most commonly used tramp iron magnetic separators are Overband Magnets, Suspension Magnets and Magnetic Head Pulleys. Overband and Suspension Magnets sit above transported ore, whilst Magnetic Head Pulleys replace standard head pulleys. In all three cases, tramp iron is attracted to the magnetic field and automatically extracted. Overband Magnets are the most commonly used magnetic separators and include a self-cleaning belt to transport captured iron away from the conveyed ore into a collection area. Suspension Magnets (Overband Magnets without the self-clean gear) hold the metal on the magnet face until manually-cleaned. Magnetic Head Pulleys attract metal to the conveyor surface, depositing underneath on leaving the magnetic field. Recent Overband Magnet installations include a gold mine in Bulgaria and coal processing plant in Russia, with a Swedish iron ore processing plant using a number of large diameter Magnetic Head Pulleys."

High-intensity magnetic separation enables the recovery or extraction of para and ferro magnetic minerals. Such technology is widely used in the processing of non-metallic minerals, as well as specialist applications including coltan, beach sands and iron ore. Once again, the magnetic force is generated by either high strength rare earth permanent magnets or electromagnetic coils.

Bunting adds: "High-intensity Drum Magnets and Rare Earth Roll Magnetic Separators utilise the extreme magnetic force of permanent neodymium rare earth magnets. In both technologies, a tightly-sized, dry mineral feed passes over the drum or roll surface, with magnetically-susceptible minerals attracted, deflected and separated using a strategically placed splitter. The electromagnetic Induced Roll Magnetic Separator operates in a similar way with a magnetic field generated electromagnetically. Non-metallic minerals such as feldspar, silica sand, and zircon are purified using these high-intensity magnetic separators."

The Magnetic Disc Separator features up to three electromagnetic discs spinning above a monolayer of dry tightly-sized minerals. Each disc is set to lift and separate minerals of differing magnetic susceptibility. Such technology is widely used in processing coltan and beach sands.

Finally, Electromagnetic Filters and Wet High Intensity Magnetic Separators (WHIMS) enable processing of mineral slurries. Single batch-fed or dual flip-flop Electromagnetic Filters remove weakly magnetic particles from non-metallic minerals, whilst the WHIMS commonly concentrates magnetic minerals.

The company adds: "Controlled laboratory testing of diverse and often complex mineral deposits identifies the optimum high-intensity magnetic separator for any given application. Many mining operations, especially in Europe, are focused on developing reserves requiring higher levels of processing or reprocessing materials previously classed as waste. Both increase the need for magnetic separation, whether to protect or purify."

Eriez on how magnetics are adapting in core markets

Jose Marin, **Eriez** Director, Minerals and Materials Processing gave ***IM*** some insights into magnetic solutions for higher purity industrial mineral separation for which demand continues to grow as new applications are released throughout the world. "What does this mean to the producers of industrial minerals who proudly produce their products, but find that the production run from yesterday will no longer suffice? Companies that do not want to get left behind must drive technological advances to produce newer, more state-of-the art equipment. Equipment advancements give companies the keys to unlock doors to new applications in changing markets. Magnetic separation is an important technology that can help make significant improvements in products and minerals by delivering increased recovery. Like most technologies, magnetic separation equipment manufacturers are constantly searching for improvements and efficiency gains in all possible processes to stay relevant and remain on the cutting edge."

The dry vibrating magnetic filter is a unique piece of equipment for processing very dry fine industrial minerals and materials requiring an

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extremely high level of purity. High level of purity in this case means a very low level of metallic impurities. “The lithium industry is one of the industries that benefits from the power of the matrix type separator which uses not only a strong background magnetic field, but the magnification of the field within the matrix to capture very fine magnetic particulates that no other piece of equipment can capture. Some of the contamination of lithium compounds is in a form single digit micron ferrous particles or weakly magnetic materials, such as wear and tear of 304 Stainless Steel. These are easily collected in the matrix while the lithium compounds flow through the matrix.”

Marin adds: “Consider that producers of lithium carbonate 10 years ago would seek contamination levels of 200 ppm of metal or less. Current market demand is for lithium carbonate with less than 50 ppb. There are no pieces of equipment that can purify this ultra-fine powder more effectively than the DVMF.” The 5000, gauss DVMF consists of a solenoid clad type of electromagnet where there is a vibrating canister through the open bore. The coils are driven quite hard and generate a substantial amount of heat that requires dissipation through the surface of the electromagnet and force cooling. The sensor based cooling system available on the Eriez unit allows an operator to monitor all the operating parameters of the unit, delivering information that can be transmitted to the central control system. Operators know the exact water and oil flows and their corresponding temperatures. Additionally, electromagnet operating data is transmitted, as well as the vibration displacement of the canister.

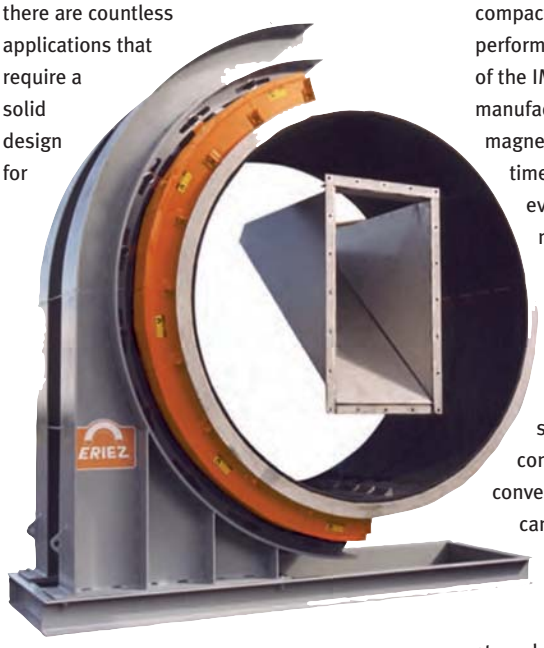
Looking at wider mining magnetics applications, trunnion magnet systems are magnetic separators that are installed at the discharge of a ball mill. “These magnets’ main objective is to remove ball chips and worn out balls from the milling circuit. It is a simple concept that requires a short stainless steel barrel and a permanent magnet around it covering an arc length of about 200 degrees on unidirectional mills. There is also a longer arc option for bidirectional ball mills. The magnetic arc induces a magnetic field into specially designed cleats inside the barrel which attract the ferromagnetic worn balls and chips as the slurry discharges from the mill. As the barrel rotates with the mill, the magnetic material is carried up to the end of the magnetic element. At this point, gravity takes over and the magnetic fraction is collected on a chute and diverted away from the mill discharge. Trunnion magnets can be used on most ore, with the exception of ferromagnetic ores such us magnetite or monoclinic pyrrhotite.”

Why is a trunnion magnet so important to a milling circuit? Marin says that unless worn out balls and chips (scats) are magnetically removed, those hard pieces of metal remain in the circuit until they are milled into a fine metallic powder and eventually make it to the concentrators (flotation, gravity or magnetic). “Knowing this, the real question becomes: Why spend so much energy milling the milling media? Ball mills are designed to mill ore and can do that very effectively when trunnion magnets are utilised. While ball mill manufacturers are already incorporating trunnion magnet systems into new ball mills, these can also be retrofitted in existing ball mills. The most important thing to remember when considering a retrofit is that the ball mill is full of chips. The mill will undergo a massive evacuation of chips during the first two to three weeks of operation which causes a reduction in power draw. This can be adjusted by adding a higher load of fresh ore to bring the system back to normal.”

Eriez states that the trunnion magnet has undergone a series of improvements in recent years, including:

- New wash water manifold to better wash the ore off the chips
- The barrel has been fitted with a 6 in extension at the end which helps properly seal the discharge of the mill
- Top section of the magnetic arc can now pivot open which effectively reduces disassembly time during barrel maintenance

Lastly, Marin discussed Wet Drums (Low Intensity Magnetic Separators/Medium Intensity Magnetic Separators) with Hybrid Magnetic Element. “Wet drums are extensively used in mining. Whether it is iron ore concentration or recovery of magnetite in heavy media circuits, there are countless applications that require a solid design for metallurgical and mechanical performance. Even though significant improvements on wet drums took place during the 90s and early 2000s, we continue to see further improvement in reliability and features on this product category.”



Eriez states that the trunnion magnet has undergone a series of improvements in recent years

Eriez developed a hybrid magnetic element with one objective in mind: improve iron recovery in the rougher stage of magnetite concentration. Comparative tests performed at an iron ore plant proved iron recovery performance. “A comparison was performed on self-levelling CDA wet drums that were 48 in diameter by 125 in wide with a 1,000 gauss interpole magnetic element versus the hybrid element. It should be noted the hybrid element develops peaks of 3,500 to 4,000 gauss, as opposed to 2,100 gauss on the 1,000 gauss interpole element. In addition to the hybrid element, a number of other magnetic elements exist. Selection of elements depends on the application, minerals, and their magnetic susceptibility, such as transitional magnetite which is known for lower magnetic susceptibility of magnetite.”

This ore can easily be separated and concentrated using the Salient Pole RE wet drum. Not all gold processing plants have a gravity circuit in their flowsheet, but those that do Marin says know the benefit of wet drums to remove magnetite and fine ferrous prior to the gravity concentrator. This allows the concentrator to operate continuously without having to deal with the nuisance of magnetite or fine steel in the bed of the concentrator.

Last but not least he covered next generation RE Roll Separators (High Intensity Magnetic Separators). Rare earth roll separators effectively replaced the induced magnetic roll separators (IMR) because of the equipment’s simple and compact design and low power consumption. Its performance was as good as or better than that of the IMR. “The early models were manufactured with samarium cobalt Rare Earth magnets and the maximum roll width at the time was the 40 in (1 m) wide. Those units evolved into the 60 in (1.5 m) and Eriez is now pleased to announce the development of an 80 in (2 m) wide RE Roll is near. The 80 in wide RE Roll is completely re-designed to bring the RE rolls to current engineering design standards. The housing has been simplified by making it ‘bolt-on’ construction as compared to the conventional welded construction. The cantilever assembly has been re-designed with fewer components and a more rugged design. Bearing replacement has been simplified so operators do not struggle with the weight of a magnetic roll that will stick to any metallic part on the machine and nearby area. The belt tracking mechanism has

been simplified to make the belt replacement procedure even faster than the previous models, but the Kevlar belts are still the longest lasting belts for that unit. Belts with diagonal splices as well as finger splices are also available."

STEINERT launches magnetic equipment e-book

Part of the challenge for suppliers is equipping customers with the knowledge they need backed up by adequate testing options. Germany-headquartered magnetic separation major **STEINERT** has recently launched a new e-book which explains how to select the right magnetic equipment for the right application. This includes tramp removal which as outlined prevents equipment used to recover bulk materials suffering serious damage from tramp iron, such as wires, nuts, bolts or excavator teeth. "All equipment used in the recovery of minerals needs to be protected from collisions with tramp iron in order to reduce wear and downtimes and, of course, to avoid huge repair costs," says Kai Bartram, Head of Mining Europe, Africa, Asia at STEINERT. The company offers various oil and air-cooled magnets and metal detectors for this purpose with several thousand of its magnets in use.

For conveying systems, STEINERT's advice for most applications is to position the magnet above the head pulley. But in some existing plant layouts such a setup is not feasible and one has to choose an installation over the belt. In that case the suspension magnet needs to lift the weight of the tramp material and additionally overcome the weight of the material above it. To realise the same separation efficiency, the size of the magnet has to be bigger or a magnet has to be installed after each conveyor transfer. So in regard to separation efficiency, an installation over the head pulley is optimal.

For mined ore streams with high tramp content, self cleaning systems include air-cooled options like the STEINERT UME with an extremely strong and far-reaching magnetic field designed for high bed depths and small tramp metal. The STEINERT UMP permanent magnets are very energy efficient since they do not require a rectifier. They are designed for lower bed depths and mainly big ferrous magnetic tramp. High intensity oil-cooled overband magnets like the STEINERT OHSM have been developed for high-capacity conveyors where the standard UME/UMP have difficulty in removing tramp metal. These magnets are proven to work efficiently even in extreme conditions.

The STEINERT BRP/BRE magnetic head pulley can be implemented in existing plants and replaces regular head pulleys. STEINERT will manufacture the magnetic head pulley according to design requirements. It can be used to separate tramp metal in all sizes as well as a method for dry magnetic ore beneficiation (cobbing). It is ideal for reclaiming small, weak magnetic particles from conveyed material.

For streams with low tramp content, STEINERT AME/AMP magnets provide a cost saving solution for separating tramp metal that occurs only occasionally. They are not self-cleaning, therefore they require a removal cycle during which the magnet has to be swung away from the belt briefly. Attracted ferrous parts fall off once the electromagnet (AME) is switched off. The weaker AMP has to be cleaned manually. The STEINERT Boomerang giant magnet works for high-capacity discharge installations. The shape of the magnet reflects the material trajectory. It is used for wide conveyor belts with high conveyor speed and layer thicknesses at extreme throughput.

The STEINERT MP magnet can be connected directly to the main power supply, which allows extremely fast commissioning and also saves space because no control cabinet and extra rectifier of any kind is needed. It works for high bed depths with tramp metal magnetics and is easy to relocate.

Finally, the STEINERT OHSM magnet is constructed for high bed depths and small tramp metals which cannot be removed by STEINERT AME/AMP. Made for extreme ambient conditions, the oil-cooled system is ideal for batch removal in the case of low tramp iron volumes.

Air-cooled magnet options include the STEINERT UME with an extremely strong and far-reaching magnetic field designed for high bed depths and small tramp metal

STEINERT magnets use coils made of anodised ANOFOL® aluminium strip, which it says provide the highest efficiency and quality. ANOFOL® is part of the STEINERT group and supplies these highest-quality aluminium strips exclusively for STEINERT magnets. As a result, the magnets are lighter and more energy-efficient than magnets with traditional copper coils.

Aside from tramp removal, STEINERT wet drum magnetic separators are used in the fine grain range from 1 µm up to 3,000 µm (0.001-3 mm) to separate magnetic particles from process liquids, sludges or emulsions. Their strong magnetic fields enable the efficient separation of magnetite or ferrosilicon from the wet medium. Either a combination of the STEINERT HGF matrix separator and STEINERT NTS wet drum magnetic separator or with extreme throughputs the large STEINERT WDS drum separator can be used depending on the grain size, the levels of ferromagnetic particles and the required throughput. The applications range from processing heavy solutions from flotation or sink/float separation, iron ore beneficiation through to the cleaning of process water from degreasing baths or coolants. The processing objective here can be both the recovery of valuable iron particles and the avoidance of disruptive iron particles, eg upstream of membrane or ultra-filtration.

In 2020, the company opened a new test and development centre in Pulheim, Germany, the company to introduce additional sorting lines for mining and waste recycling. The new lines have been installed in an effort to better achieve the company's aspiration of "test before you buy." By opening the new building, the company has trebled its testing capacity, allowing it to be more flexible in responding to customer demands. "The processing sequence deployed in the sorting systems is the same as that used in a real industrial plant," Peter Funke, CEO of the Steinert Group, said. "We are delighted that even more customers can try out our technology, from magnetic separators to sensor-based sorting systems, such as X-ray transmission, X-ray fluorescence and near-infrared (NIR)."

Mineral Technologies – still innovating at 80

A global leader in gravity separation, **Mineral Technologies** (MT) says it leads the way in equipment design and manufacture, metallurgical testing and process plant design.

Presenting at a recent company-wide event to celebrate MT's 80 years, General Manager, Alex de Andrade said that innovation was core to MT's success. "Our strong innovation focus has ensured that we have consistently delivered ground-breaking new technologies to help our customers improve their global mineral processing operations. As we enter our next 80 years our team is delivering some of the most significant new technologies in the industry."

He went on to outline latest developments in modular plants, mobile mining units, innovative surge bin technology and 3D printing. Mobile Mining Units (MMU) represent a high-performance solution, and have been designed by MT for mining sites where traditional mining or dredging is not an option, or not cost effective. The technology delivers improvements in availability, orebody yields, throughput and overall mineral recovery. Suited to sand environments that include organics such as tree roots, light clay and soft or friable rock, MMUs can reduce operating costs by eliminating the need for conventional truck and shovel mining. MMUs have recently been delivered to a world leading chemical company in North America, Chemours. The MMUs are extracting difficult to reach mineral sand deposits where traditional mining methods didn't stack up as the best business case. The MMUs provide a far safer and substantially reduced cost per ton solution compared to other options such as truck and shovel mining.

He also cited another proven innovation from the MT process engineering team in the form of the Lyons Feed Control Unit (LFCU) which proudly bears the name of development team leader John Lyons. The LFCU delivers world's best practice in feed control technology. Manufactured exclusively by MT, the LFCU is an advanced, technology-driven, smart surge bin. It's use in mineral sands plants worldwide has resulted in consistent slurry density at the LFCU discharge point despite large fluctuations in feed flowrate and density into the bin. Initially designed for mineral sands, MT's latest LFCUs are being delivered to a major iron ore producer in Western Australia. These will be

Mineral Technologies Mobile Mining Unit (MMU)

The new Multotec SC25 spiral concentrator has shown significantly higher metal recoveries for minus 1 mm fractions in ferrochrome slag when compared to traditional spirals

the largest LFCUs designed to date and will separate very fine magnetite from silica, alumina and other contaminates. The stable density and feed controls are benefits to the process, but the main benefit to MT's customer is the fine particle separation with much less water than competing technologies require.

Elsewhere, MT's new range of modular plants provide fast, cost-effective process solutions for mining operations worldwide. "Incorporating robust design reflecting 80 years' engineering experience, modular plants are ideally sized for road, rail and ocean freight making them easily transportable to site. Once on site, MT's modular plants are quick to assemble and can be operating in up to half the time required for conventionally constructed plants." Modular plant designs featured in MT's tailings recovery solutions to the chrome industry in Southern Africa including plants for Samancor. These designs incorporate the latest wet high intensity magnetic (WHIMS) technology. Providing an alternative to mining more feed material, the WHIMS plants process existing waste streams from current operations, essentially recovering what the conventional plants leave behind.

The new HTR400 is an expansion of the MT electrostatic separation range delivering increased throughput, next generation technology and greater flexibility in configuration with superior throughput as well as improved usability and ease of maintenance. "These machines have been developed to offer additional sensor adoption and through IoT connected devices they can be setup to offer a live dashboard to the operator's mobile device for key setpoint prompts and optimisation recommendation messages. Coupled with a glass less composite material electrodes the cost of spares and fragile damage in traditional electrodes is overcome and far safer to store and maintain without compromise to performance."

MT is currently delivering the first shipment of 21 HTR400 machines to a mineral sands customer in India.

Finally, MT told ***IM*** it is working with research alliance partners University of Technology Sydney (UTS) and Innovative Manufacturing CRC (IMCRC) to research solutions that will revolutionise the way mining products are manufactured by using additive manufacturing, or 3D printing as it's more commonly known. The end goal of the alliance is to allow Mineral Technologies to manufacture bespoke models for mineral separation spirals, sent directly to a 3D printer solution. The commercial benefits include the ability to print on site and in real time which will ultimately deliver savings in both time and money. "We are excited about the opportunities that our alliance and this particular research project will help to deliver. Beyond commercial benefits are the positive environmental impacts such as decreasing the need for chemicals and reducing air contamination in the manufacturing process," said de Andrade.

Multotec's new SC25 spiral

Looking at another gravity-based technology, following years of detailed test work in the ferrochrome sector, **Multotec** has successfully developed and proven a spiral concentrator that eliminates beaching and enhances recoveries in the 1 mm to 3 mm fractions of high density material.

Significantly, when compared to traditional spirals the new spiral has shown extraordinarily higher metal recoveries, even for minus 1 mm fractions in ferrochrome slag.

"Our SC25 spiral concentrator features steeper angles which facilitate the flow of material and increase separation efficiency," says Hlayisi Baloyi, Applications Engineer at Multotec.

"It also widens the particle size range that can be treated by the spiral. Traditionally, spirals would struggle to efficiently treat material above 1 mm in heavy mineral applications, but this spiral can go well beyond that. The spiral has been a game changer even for the minus 1mm size range where higher separation efficiencies have been achieved on chromite ore."

Baloyi says that this innovation has provided the minerals processing sector with an exciting alternative to jigs in the minus 3 to plus 1 size range, which have been one of the conventional methods of separating larger particles. The solution is cost effective as spirals use no electricity, and are also easy to maintain. So attractive is the new model that the first order for the commercialised version has already been placed.

"Taking ferrochrome samples from a number of mines over a period of two to three years, we conducted extensive test work on these at our well-equipped testing facility in Spartan near Johannesburg," he says. "Leveraging this data with our in-house engineering design capacity, we were able to develop the optimal solution and locally manufacture the new spiral concentrator."

The institutional knowledge within Multotec has been developed over more than four decades, including valuable expertise in fluid dynamics. Hands-on experience in test work and design allows the development of prototypes that solve customers' specific challenges – followed by scaled-up local production of equipment to match market demand.

The economic benefits of the Multotec SC25 spiral for ferrochrome producers are substantial, as some plants were losing the value of their 1 to 3 mm material to the tailings storage facility. Many of those who used jigs to treat this fraction were also finding that their efficiencies were low.

"Ferrochrome is not the only commodity that we have successfully tested," says Refentse Molehe, Process Engineer at Multotec. "We have even seen improved recovery in heavy minerals below 1 mm size, alluvial chrome, manganese slag and there is potential in industrial recycling."

The recycling application opens up options for 'urban mining' – the recovery of metal particles from associated waste. Multotec has received a number of requests and conducted tests to recover metals from recycled electronic goods and from customers who intend to recover metal from industrial scrap.

FLSmidth launches GX Concentrating Cone

Moving on to advanced gravity separation, and the latest innovation in semi-continuous gravity separation from **FLSmidth** is delivering a key breakthrough in performance that increases recovery and cuts maintenance downtime, according to the OEM. For decades, Knelson gravity concentrators have been recognised for their recoveries of gold and precious metals, but the development of the new Knelson GX Concentrating Cone is set to take this performance a step further.

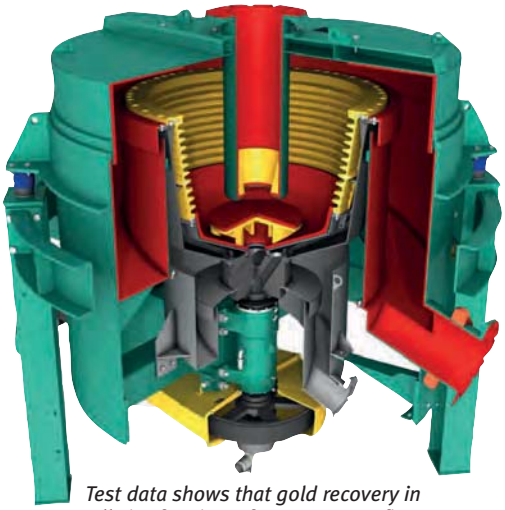
The new patented GX Cone delivers impressive recovery enhancements due to enhanced water distribution within each ring, according to the company. FLSmidth explains: "As water enters from the base, it flows through zone separator nozzles for a customisable fluidisation profile. This allows for even distribution of water in each ring; the new design also significantly increases the active recovery surface area. The result is a step change in overall coarse and fine gold recovery."

AKW A+V enables ultrafine sand recovery with cyclones

Looking again at industrial minerals, since most of the existing silica sand processing plants are not designed for ultra-fine sand recovery, a significant amount of product is lost in the 0-150 µm range. In order to reduce this loss of product and maximise the recovery of fine sand, as well as reduce the load on sludge sedimentation ponds and ensure a better water circle management, the R&D department of **AKW Equipment + Process Design** has been intensively involved in the designing of a new process. This was followed by the development of a customised technical solution combining ultrafine hydrocyclone classification with dewatering of critical sand material, the so-called AKA-SILT System. From an existing treatment plant, approximately 200 m^3/h of solids-laden process water is fed to a pump sump via a pump. With an additional wear resistant slurry pump, the suspension is fed to the first hydrocyclone stage, the AKA-SPIDER annular distributor. An installed antiblocking filter, AKA-STRAINER, retains any larger particles that may be present and thus avoids blockages in the distributor, which could lead to variances in the classification. The material is classified at 10 µm by using small polyurethane hydrocyclones AKA-VORTEX. The hydrocyclone overflow with the fines 0-10 µm is discharged into the sedimentation pond, whereas the hydrocyclone underflow fraction 10-150 µm is directed by a pump to the second hydrocyclone stage. The AKA-SPIDER annular distributor, also equipped with polyurethane hydrocyclones AKA-VORTEX, is used to thicken the fraction 10-150 µm. The hydrocyclone overflow from this second hydrocyclone stage is returned to the first stage circuit. The discharged hydrocyclone underflow 10-150 µm is fed onto the dewatering screen, dewatered and then stockpiled by a conveyor belt. The underflow of the screen is returned to the pump sump of the second stage. Both products, the ultrafine sand (10-150 µm) and the pure clay (0-10 µm) are marketable as products for further processing industries. The significant reduction of the fines content in the suspension leads to a high economic, ecological and efficient water treatment and also to a relief from any downstream installed sedimentation ponds or thickeners.

The AKA-SILT system can be installed as an additional unit in existing plants and achieves the highest environmental standards as a 100% chemical-free process. With this new system, it is possible to benefit from an environmentally friendly process unit that can process fine material which normally is discharged in ponds.

The AKA-SILT system can be installed as an additional unit in existing plants and achieves the highest environmental standards as a 100% chemical-free process



Test data shows that gold recovery in all size fractions, from coarse to fine, improved significantly with the FLSmidth Knelson GX Cone

Test data shows that gold recovery in all size fractions, from course to fine, improved significantly with the GX Cone, according to the company. By incorporating an advanced distribution of fluidisation water across the entire concentrating cone, the Knelson GX facilitates the highest possible recovery of coarse and fine gold. At the same time, balanced water distribution across the concentrating cone allows for a significant reduction in fluidisation water requirements while improving recovery.

The third major benefit of the Knelson GX is easier maintenance. Because it is made of a customised, abrasion-resistant and durable polyurethane compound, maintenance frequency and operational costs are significantly reduced, FLSmidth says. Mike Lefler, Head of Global Product Line Manager for Precious Metal

Recovery at FLSmidth, said: "The new Knelson GX Concentrating Cone is the culmination of over 40 years of research and operational experience and is exciting news for our customers. It delivers a win-win-win scenario: better recovery, less water use and less downtime due to easier maintenance. "In short, it helps customers produce more with less resources – a central tenet of our MissionZero ambition to cut water and energy waste in mining by 2030."

Sepro looks to eliminate water consumption

Canada's **Sepro Mineral Systems** is developing a new gravity concentrator that eliminates water consumption during gold recovery processes. The current Falcon SB Gravity Concentrator, which recovers precious metals like gold, flips between periodic run and rinse cycles. It is the most common unit used in gold processing within grinding circuits. The SB is a "Semi-Batch" unit, meaning it continually accepts feed during a run cycle, but only produces concentrate during periodic rinse cycles. The cycles last from five minutes to several hours, depending on the application.

"While process water consumption for this machine is already low, we're challenging ourselves to find a way to maintain high levels of gold recovery while eliminating any need for excess water. This will improve mill circuit performance and reduce the amount of water that needs to be removed later in the process."

Canada's Sepro Mineral Systems is developing a new gravity concentrator that eliminates water consumption during gold recovery processes

The Falcon C and UF models already require no fluidising water to operate. The C model is used to improve the efficiency of gold recovery operations or as pre-concentration devices; while the UF tackles gold ores which contain carbon that can interfere with the leaching process. Flotation is used to remove the carbon before leaching. However, during the flotation process, extremely fine gold particles will float with the carbon. This gold would normally be lost to tailings, but the UF has the power necessary to recover the gold from this carbon-gold slurry.

"Those familiar with the use of Falcon or the Knelson concentrators for gold recovery know that the units require quite a bit of fresh water to operate. As such, Sepro has had a project going on for a while now to try to eliminate the need for additional water in these batch concentrators. There have been some very good results using a particular mechanism for concentration that does not require water and the Sepro team is working on mechanically scaling that up to the industrial units."

Another study has been examining bowl profiles and seeing if there is something that can be done to improve recovery by changing bowl profiles.

A second research project Sepro has in the works is a gravity separation computer simulation model. When this model is completed, it says it will be able to perform R&D and technology development on a computer rather than building circuits and running experiments. "Lab experiments are costly and time-consuming. Once the model is complete, we'll be able to do our development work via computer. It will be the first time anyone has developed a model capable of performing these specific tasks to improve operations. The model is one of a kind and our research will allow us to capture the physics and flows of fine mineral slurries with applications for large industrial machines as well as pilot-scale equipment."

Finally, away from gold, many of the high specific gravity minerals of interest are friable (eg tin ores cassiterite, wolframite) and excessive fines are generated in the grinding/comminution circuits which cannot be recovered with conventional gravity equipment like spirals and may be lost directly to the tailings stream. "Recent developments in centrifugal gravity separation equipment specifically designed for fine or ultra-fine particle separation and recovery have resulted in heavy mineral particle recoveries as fine as 10-20 microns. Ongoing research work has also identified the benefit of closed-circuit, multi-stage gravity recovery circuits using some combination of centrifugal concentrators and conventional equipment (tables, spirals, flotation etc) which can substantially increase overall plant recovery and final concentrate grade." IM