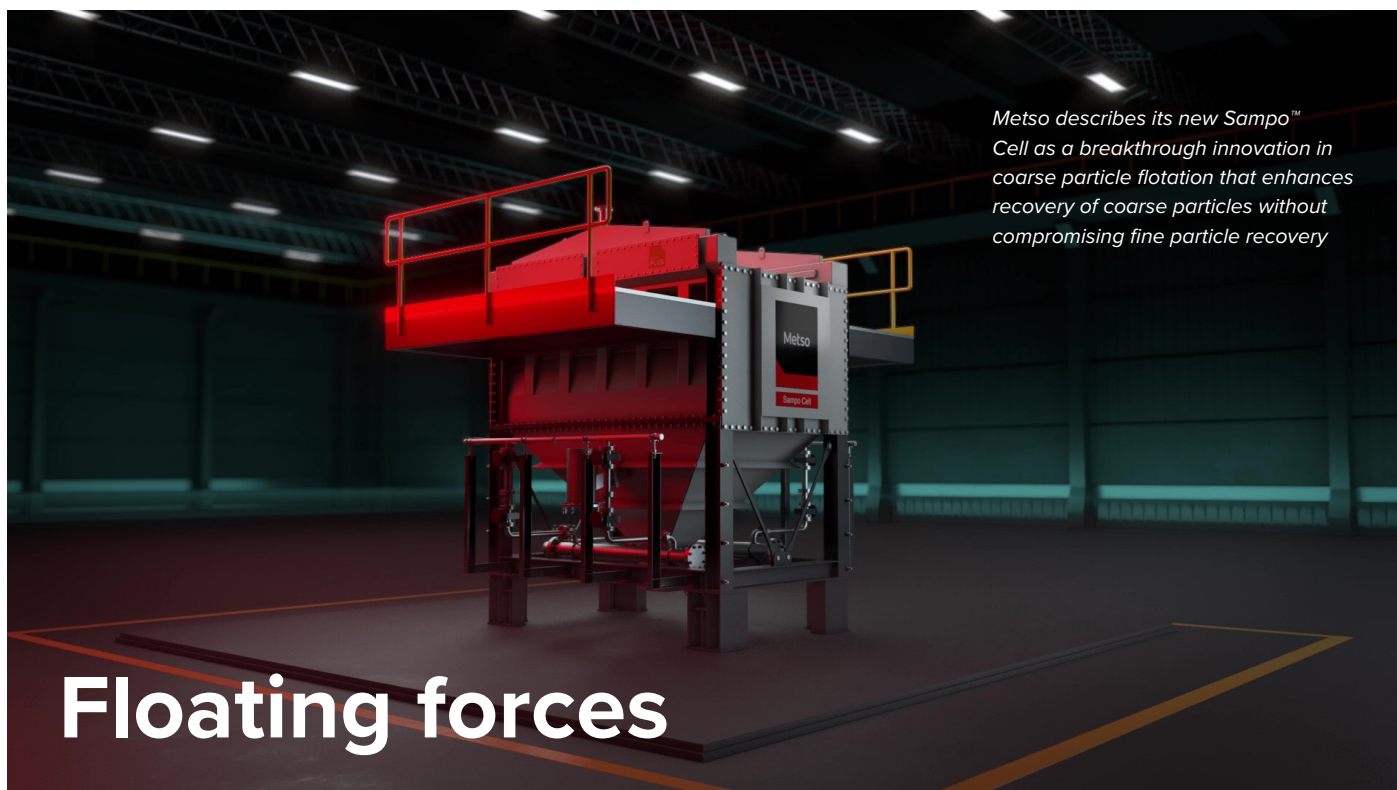




Metso describes its new Sampo™ Cell as a breakthrough innovation in coarse particle flotation that enhances recovery of coarse particles without compromising fine particle recovery

Floating forces

The most significant flotation development this year was from **Metso**, which in September 2026 introduced the Sampo™ Cell, which it describes as a breakthrough innovation in coarse particle flotation that enhances recovery of coarse particles without compromising fine particle recovery, helping mining companies improve the efficiency, profitability, and sustainability of their operations. In Finnish mythology, Sampo is a magical device forged by the blacksmith Ilmarinen that brings riches and good fortune to its holder.

Based on a froth-feeding principle, the Sampo Cell technology gently feeds slurry directly into the froth phase, where separation takes place under low-turbulence conditions. This minimises particle detachment and enables efficient recovery of particles that are typically lost in conventional flotation circuits. The Sampo Cell can be applied for front-end gangue rejection or as a scavenger stage to recover valuable particles from intermediate or final tailings.

The Sampo Cell is a pneumatic flotation cell operated using standard flotation control variables such as superficial gas velocity, froth height and reagent addition. Because these parameters are commonly used in conventional flotation circuits, the technology can be readily implemented within existing process control systems while targeting improved recovery of coarse particles. By avoiding high turbulence and feeding the slurry directly to the froth environment, the cell promotes stable

Paul Moore looks at a major coarse particle flotation technology introduction plus other key developments in this critical part of the flowsheet

bubble-particle aggregates and reduces detachment of coarse particles. In addition, the absence of fluidisation water simplifies the flowsheet, reduces process water demand, and minimises the need for auxiliary equipment. According to Metso, this makes the technology particularly attractive for coarse particle recovery and scavenging applications.

“Mining companies are under increasing pressure to process more complex ores, improve recovery while reducing their environmental footprint. The Sampo Cell represents a significant leap forward in flotation technology. By expanding the recoverable particle size range and simplifying coarse particle flotation, customers can unlock additional value from existing operations,” says Teemu Kaarniemi, Senior Vice President of Separation at Metso.

Traditional flotation circuits typically require extensive grinding to bring particles into an optimal range for efficient recovery. The coarse particle flotation changes this paradigm by expanding flotation performance to significantly coarser and less liberated particle sizes. The Sampo Cell design also simplifies coarse particle flotation flowsheets compared to other solutions.

The Sampo Cell does not inherently

require feed classification, fluidisation water, or additional concentrate dewatering stages, reducing equipment requirements and supporting easier integration into existing plants. The technology is capable of efficiently floating the full particle size distribution, and its performance is not dependent on feed classification. In Sampo-based circuits, classification may be applied for economic optimisation rather than operational necessity. When the fine fraction contains little recoverable value, a simple single-stage cyclone classification step can be used to remove these low-grade fines, enabling a smaller and more cost-effective circuit focused on the higher-value coarse fraction. The Sampo Cell uses familiar flotation controls and instrumentation, making implementation straightforward for plant operators. The Sampo Cell is part of the Metso Plus portfolio, supporting more efficient minerals processing through improved energy and water efficiency and higher resource recovery.

Since March 2026, the Sampo Cell has been in continuous 24/7 operation in industrial-scale scavenger duty at a copper mine in Chile – specifically as a scavenging technology for recovering copper from rougher tailings containing a high proportion of coarse and partially liberated particles at Grupo Minero Las

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Cenizas's Las Luces concentrator in Antofagasta, Chile. Approximately 30% of the total tailings stream is processed, and the Sampo Cell has delivered a significant increase in overall copper recovery. In continuous industrial operation and across a broad range of operating conditions, the CPF cell consistently achieved copper stage recoveries exceeding 60%, with recoveries above 80% attained at moderate mass pulls. Concentrate grades were at least twice higher compared to the main concentrator feed grade, enabling the recovered material to be returned to the circuit for regrinding and subsequent conventional flotation, with the objective of increasing overall recovery. Importantly, the Sampo concentrate has been directly sent to the regrinding circuit without the need to dewater it, with solids percentage between 25-35%. These results were obtained without excessive mass pull, supporting selective recovery of valuable minerals while minimising the impact on auxiliary equipment and downstream capacity.

"The industrial-scale operation in Chile has validated both the performance and scalability of the Sampo Cell. The results show how customers can improve overall plant recovery without major changes to the existing flotation circuit," says Antti Rinne, Vice President of Flotation at Metso.

Metso says the launch of the Sampo Cell further strengthens its leadership in flotation technology. Metso offers one of the industry's most comprehensive flotation portfolios, covering mechanical flotation, pneumatic flotation, flotation services, process expertise, digital optimisation tools, and aftermarket support.

Combined with Metso's crushing, screening, grinding, filtration, thickening, and tailings solutions, customers benefit from an integrated approach that optimises performance across the entire minerals processing flowsheet.

IM Editorial Director Paul Moore travelled to Metso's headquarters in Helsinki and its Research Centre in Pori, to find out more about the technology – meeting in person with Antti Rinne and with Marly de Avila Carvalho, Product Manager, Coarse Flotation.

Rinne commented: "We investigated several different options on how to best do coarse particle flotation and tried to look at the big picture, what is making the existing CPF alternatives complex, especially for brownfield operations. We considered that the additional equipment required for fluidised beds was what made these current technologies complicated, in our view – and we saw that there might be ways to overcome those issues."

Rinne added that the drivers to develop Sampo without using fluidisation were the

need for multiple stages of classification, and the amount of water used – which means large pumps and significant energy consumption. "More classification also means greater height, which in turn requires more structural steel and additional pumping, making it very expensive from an overall project point of view."

"As a result, the Sampo Cell enables a remarkably compact circuit design, with



IM Editorial Director Paul Moore with Metso's Marly de Avila Carvalho (right), Product Manager, Coarse Flotation; and Antti Rinne, Vice President of Flotation (left)

significantly lower height requirements compared with conventional flotation and other coarse particle flotation solutions. While feed classification is not required for the Sampo Cell, it may be beneficial in certain applications depending on the project requirements and, when applied, only a single classification stage is typically sufficient. This compact configuration can significantly reduce building height and overall plant footprint, making the technology particularly attractive both for greenfield projects and for retrofits with space and structural constraints."

Carvalho added: "One other advantage that I think is crucial is that if you are adding a lot of water in the cell, that water needs to go somewhere. And in the fluidised bed based equipment, that water goes to the concentrate, otherwise fluidisation will not function properly. So, the mechanical design of the equipment means that it dilutes the concentrate. So then that water needs to be removed from the concentrate for the concentrate to go to the grinding circuit and then return to the process. In our Sampo Cell, we don't have fluidisation water, we are just adding enough water for the flotation process, and the solid percentage that we are getting in the concentrate can go straight to the regrinding circuit. So we are skipping a dewatering stage. And on top of that we have a much simpler classification

process when it is required, and often it is not required. These are simplifying the circuit a lot. And on top of that, treating that water from dewatering means additional equipment and additional cost and footprint in the plant."

So where does Metso see the greatest initial potential? The demo plant is at a relatively small copper operation compared to the very large copper mines. Rinne: "But

we definitely wanted to test it with copper because if you look at the market potential for CPF, more than half of that will be for copper, as this is where the largest tonnages are processed and where the largest grinding circuits operate."

Carvalho: "In our opinion, if the biggest mines – both greenfield and brownfield - don't start using coarse particle flotation soon, they will not be in operation in the future,

due to factors like low grades, comminution energy costs, limited space availability and water shortages, and crucially a move away from wet tailings storage."

Where is Sampo to be installed to maximise results for the customer? Rinne: "If the customers are looking for a big increase in plant capacity, then it must be in the beginning of the flowsheet. If they are looking to increase plant recovery or throughput, then it's in the end of the flowsheet for scavenging of tailings. Because tailings duty is the easier application at this stage, coarse particle flotation will first happen in plant capacity related use, and gangue rejection will happen in the medium term. It will also take time for the market to fully accept coarse flotation and to better understand the advantages but also the risks."

Rinne and Carvalho said that in a tailings application, in most cases it will be possible to push more throughput as you can grind coarser with the existing grinding capacity. Some particles will be lost in normal flotation because there is insufficient liberation for recovery to occur in the main flotation circuit, but then in the scavenger or tailings stream Sampo will recover the remaining metal. Rinne: "In most cases we will still be able to achieve at least 5-10% capacity increase. In the industry already today, when the copper prices are high, mines already make more money by increasing throughput and decreasing recovery so there's a lot of opportunity for coarse flotation in these situations."

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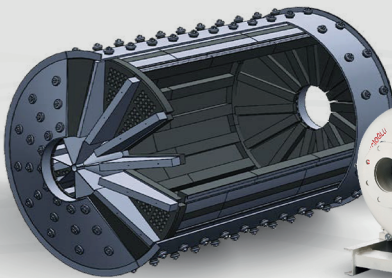
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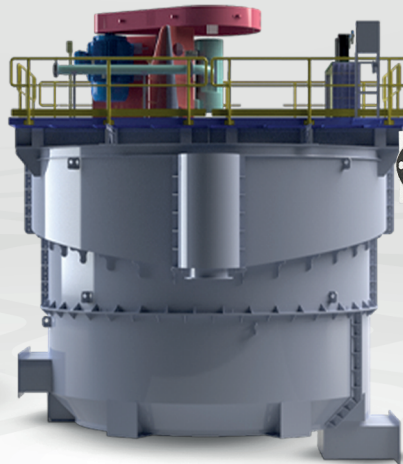
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Upfront, in the grinding circuit, there is potential to reject 50% of the mass already before going to the final grinding stages. Carvalho: “Even if we remove 30% to 40% of the total non-valuable mass at that point, we can create final tailings there already. So that is a game changer, not only for the potential capacity increase but because significantly coarser final tailings mean you can use a totally different approach to tailings processing, like dry stacking.”

Rinne: “If you must classify the ore at the beginning of the circuit before CPF, it means that all the fines have to be separately processed in a conventional flotation circuit. If you, for example, have 20% of the plant throughput going to the CPF, your gangue rejection is limited to what is going to the CPF. When feed classification is not required, the gangue rejection potential can be significantly greater, and it allows us to have a higher mass pull and achieve higher recovery. In all the gangue rejection applications we’ve studied so far, we haven’t needed classification at all.”

Metso did test work and simulation in a gangue rejection application without Sampo feed classification, where it was rejecting 45%, which means Sampo had a 55% mass pull, meaning you could increase the plant throughput by 82%. Carvalho: “So not classifying the feed has a huge impact in the potential of increasing the plant capacity. Practically speaking it is hard to increase a plant throughput by this order of magnitude in a brownfield situation but in a greenfield project, it means that the plant can process a much bigger tonnage of ore with a much smaller footprint.”

What does that plant look like from a comminution point of view? What type of comminution is ideal to maximise the potential of CPF? Rinne: “In the gangue rejection upfront, the CPF will change the comminution strategy as well. The same equipment works, but we will target much bigger particle sizes, which will save grinding capacity or increase plant throughput. New Metso Loesche technology is also a very interesting alternative here. We will end up with a coarser first concentrate, and a Vertimill is then ideal for regrinding the CPF concentrate. All of this means a lot of saved cost and energy.”

FLS RFC continues to garner interest

Staying with innovative flotation cells, but for fine particle recovery, **FLS** says its REFLUX™ Flotation Cell (RFC™) radically alters perceptions of froth flotation performance. It operates at extreme levels of gas and feed flux, and fluidisation wash water to deliver up to tenfold higher throughput, with enhanced grade and recovery, all with a smaller plant footprint.



The FLS RFC is now seeing increased interest across metal sulphides and industrial minerals - this shows a full sized cell trialled at KGHM's copper operations in Poland

The high-shear pre-contacting spargers and inclined channels allow operation under air-flooded conditions, delivering high operational gas flux rates while reducing bubble size. This increases the available bubble surface area flux by a factor of four compared to traditional flotation cells, significantly increasing collision and attachment rates. Contact between bubbles and floatable materials occurs in a high shear rate environment, elevating recovery rates.

Lance Christodoulou, Global Product Director for REFLUX™ Technologies at FLS told **IM**: “The RFC is a leading flotation technology but still relatively new in the industry. We are now seeing major interest because of its ability to shift the grade recovery curve and reduce the required flotation volume substantially, which has a significant CAPEX and OPEX impact. We’re seeing improved performance versus conventional flotation in terms of both recovery and grade. This includes copper applications, where we completed trials with KGHM in a full-scale installation in Poland. This EIT RawMaterials funded project is now complete but now we have another major miner interested in using the full-scale cell we built for that work for moly flotation.”

In that specific application, FLS was able to reduce the required retention time by a factor of 10. So where the plant was utilising a retention time of 30 minutes, the RFC was able to achieve the same recovery and grade in 3 minutes.

Elsewhere, at a major southeast Asia copper mine, a 2 m RFC (RFC2000) was part of a successful pilot trial for processing

smelter slag tails and cleaner scavenger tails, assessing potential recovery improvements.

Another example in copper is with BHP at Carrapateena, where a RFC was tested alongside a Glencore Technology Jameson Cell. This work was presented in a paper at *MetPlant 2026*. Carrapateena conducted a pilot test program with the RFC and investigated its effectiveness at rejecting fine non-sulphide gangue (NSG) without reduction in copper recovery. This was in a cleaner-scalper duty. The RFC was found to recover copper at an equivalent rate to the existing plant whilst reducing entrainment of fine non-sulphide gangue by approximately 50% in fine size fractions. Flotation tests of the RFC concentrate resulted in no meaningful increase in copper grade, indicating concentrates produced were near the maximum grade achievable by flotation.

Considering the promising results from the pilot plant, BHP and FLS agreed to demonstrate a 2 m diameter RFC (RFC2000) at Carrapateena. The RFC2000 is now being delivered and installed later this year and will increase the capacity of the cleaner circuit, resulting in modest increases to overall recovery and concentrate grade.

There are also now commercial installations of the RFC – namely at a US industrial mineral mine operated by a global industrial minerals producer. It selected multiple REFLUX™ Flotation Cells (RFC™) for service in a reverse flotation application. FLS: “In this challenging duty, silica is removed to produce a high-grade product. This milestone is the culmination of lab testing, pilot testing, and a full-scale industrial trial. One RFC™ has the capability to replace a row of up to ten conventional cells, significantly reducing the flotation plant footprint as well as operating and maintenance costs.” FLS added: “Reducing OPEX on a duty like this takes a real partnership. Many thanks to the customer’s team, who know their process and have tested our technology thoroughly. That work continues together, backed by our process technology expertise and lifecycle support. Partnerships like this turn innovation into the trusted standard.”

Moving to FLS CPF technology, coarseAIR is based on the REFLUX Classifier (RC), a highly efficient fluidised bed separator widely adopted in the mining industry to improve fine particle recovery. The coarseAIR solution combines the hydrodynamic advantages of the RC with the selectivity benefits of flotation to float larger particles than conventional flotation processes, which are typically limited to particles of <200 µm.

The coarseAIR cell operates as an aerated fluidised bed separator, where coarse particles are floated without the

high levels of agitation seen in conventional cells. This helps to prevent bubble-particle detachment seen with coarse particles in traditional systems. At the same time, the fluidised bed acts as a semi-permeable layer, avoiding the loss of bubble-attached coarse particles to the underflow.

Christodoulou: "The coarseAIR is a more recent introduction than the RFC, but we have already run some test campaigns in feldspar, where we've shown that we can recover coarse particles very efficiently. We have improved the circuit performance for that specific operation, and we are talking with them about how to implement the technology at full scale in the circuit."

He adds: "We've also got another application in potash that we're going to trial in the coming months where we're targeting coarse particles, and doing a kind of split float where we've got conventional cells going after the -300 to -400 micron material and the coarseAIR going for the +400 micron material. We are currently waiting for those pilot results which should be forthcoming in the next couple of months."

Looking at coarseAIR and sulphides, including copper, Christodoulou said that a number of tests have also been carried out. "This included a tailings stream, where we took the feed of about 0.065% copper and were able to recover between 60 and 80% of the copper on that stream, taking it down to 0.028% copper in the tails with the

coarseAIR. Looking at a tailings treatment module, which includes a regrind mill plus coarseAIR pumps and sumps, depending on how we run it, the payback period for that module would be as little as six to eight months. So, the economics are pretty strong."

Eriez and HydroFloat coarse particle flotation

Mining companies are under increasing pressure to produce more metal while reducing energy consumption, water use and operating costs. As a result, there is growing interest in technologies that can

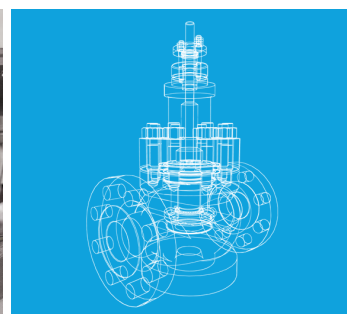


A HydroFloat CPF-300 installation - HydroFloat is an aerated fluidised-bed separator which combines the benefits of density separation with the selectivity of flotation

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improve resource utilisation without relying solely on finer grinding and additional comminution capacity.

One of the most significant developments in this area has been the advancement of the HydroFloat® coarse particle flotation technology from **Eriez**. Originally developed for industrial mineral applications, HydroFloat has now been operating successfully in commercial sulphide applications for more than five years, demonstrating its ability to deliver value in full-scale operations.

The opportunities being evaluated today extend beyond recovery improvements alone. In copper applications, coarse gangue rejection is attracting attention because it allows waste material to be removed before energy-intensive grinding. By reducing the amount of material reporting to downstream comminution circuits, operators have the potential to increase throughput, lower energy requirements and improve overall project economics while maintaining recovery performance. Vale Base Metals (VBM) has recently announced that it will be using CPF-300 HydroFloat cells in a coarse gangue rejection application at the Salobo copper operation in Brazil.

The CPF project is expected to add 6 Mt to the Salobo plant's annual ore processing capacity, bringing overall processing capacity to the aforementioned 42 Mt/y nameplate. Annual copper production is projected to increase by up to approximately 30,000 t contained in concentrate, which will also carry approximately 15,000 oz of gold as a by-product, further enhancing Salobo's production profile following record output in 2024 and 2025.

Shaun Usmar, CEO of VBM, said: "The CPF Project reinforces what sets VBM apart: our ability to unlock significant value and growth from world-class assets through execution, innovation and astute capital allocation. Salobo is already one of the world's premier copper operations, and this project will allow us to produce more copper, more efficiently, using existing infrastructure while improving environmental performance."

Another promising application is in tailings scavenging. Many operations have increased throughput over time, often resulting in coarser grind sizes and greater coarse particle losses. HydroFloat can be deployed to recover a portion of that material before it reports to tailings, helping offset recovery losses that may occur as plants push for higher production rates. A recent installation was commissioned last year at BHP's Carrapateena in Australia. The HydroFloat technology has increased overall ore throughput at Carrapateena to around 20,000 ore tonnes per day, reducing power consumption by allowing the mill to use a

coarser grind size, and improve overall metal recovery.

Looking ahead, HydroFloat is continuing to expand into new commodities. Eriez' first HydroFloat iron ore installation was commissioned earlier this year at Quebec Iron Ore's Bloom Lake facility in Canada for floating coarse silica, opening the door for other iron ore applications.

Ultimately, mining companies are increasingly evaluating coarse particle flotation not simply as a recovery technology, but as a tool for improving throughput, reducing energy intensity, optimising flowsheets and unlocking value that may otherwise be lost. As more operations pursue these objectives, the industry's understanding of what is economically recoverable will likely continue to evolve.

NovaCell™ advancing towards full-scale implementation

Jord says its NovaCell™ offers a differentiated approach to CPF circuits by processing the full particle size distribution in a single device, removing the need for upstream feed classification while recovering valuable minerals across the feed.

Sherwin Morgan, Jord Global Technology Manager – NovaCell™, told **IM**: "Current CPF circuits require upfront classification to reject fines to remain stable and recover coarse particles. This represents an additional cost and complexity that most of our clients would like to avoid. It also requires the rejected fines to be treated elsewhere or remain lost in the process."

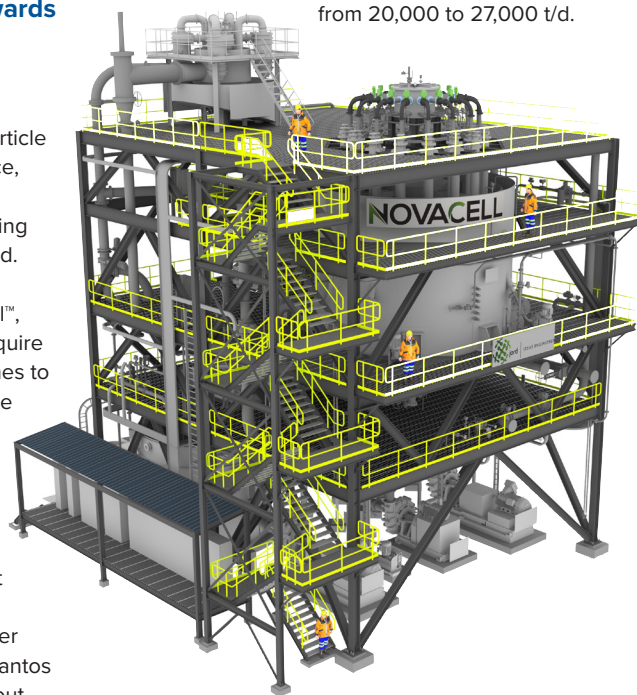
In late 2024, Capstone Copper piloted Jord's NovaCell™ at its Mantos Blancos operation in Chile, without upfront classification, in a rougher tailings scavenging duty. The NovaCell™ pilot plant demonstrated up to 56% copper recovery and consistently exceeded targets for upgrade ratio (>6) and mass pull (~8%). Importantly, this recovery was achieved using a single flotation unit rather than multiple cells in series. Mineralogy showed the NovaCell™ could effectively recover coarse (>212 µm), poorly liberated particles (<30% surface exposure) that are typically lost in conventional flotation cells.

Sherwin adds: "During the three-month trial, the feed to the pilot plant was highly variable; however, the plant remained stable without operator intervention, demonstrating the robustness of the NovaCell™ design."

Brandon Akerstrom, Capstone Copper Director of Metallurgy, states: "Capstone Copper recognises the significant value that CPF can bring to our operations. The

NovaCell™ offers a distinct advantage by recovering valuable minerals across the entire particle size distribution generated by our existing comminution circuits. Moreover, it requires smaller downstream infrastructure to produce a marketable concentrate, significantly reducing capital expenditure compared to other CPF technologies we have assessed."

Following the successful pilot campaign, the positive results supported progression to full-scale design. A detailed engineering study for the installation of Jord's NovaCell™ at Mantos Blancos in a rougher scavenger duty has now been completed. The proposed full-scale circuit uses a single NovaCell™ installed at the end of the existing circuit. Capstone is also progressing broader optimisation and expansion studies at Mantos Blancos, including a potential increase in concentrator throughput from 20,000 to 27,000 t/d.



Jord's NovaCell™ offers a differentiated approach to CPF circuits by processing the full particle size distribution in a single device, removing the need for upstream feed classification while recovering

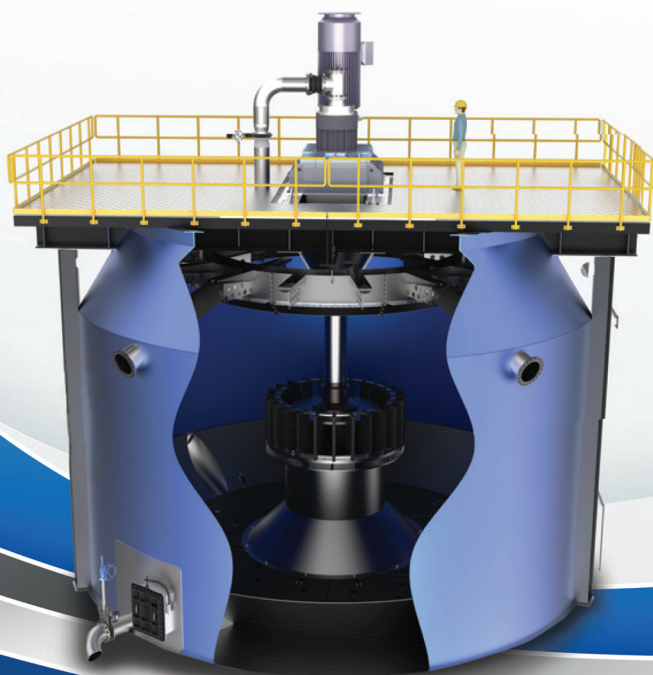
Sherwin closes: "By eliminating the upfront classification circuit in the CPF circuit, Jord has been able to provide a plant solution with a capital intensity (US\$/t Cu) significantly lower than a number of recently installed CPF circuits."

Jameson Concentrators at South32 Hermosa and Valterra Platinum

South32's Hermosa project is setting a new benchmark for mine design, with **Glencore Technology's** Jameson Concentrator selected to support a safer, more efficient and increasingly automated processing operation.



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Close up of Jameson Cell at Valterra Platinum's Mogalakwena North

Located in Arizona, USA, Hermosa is a critical minerals project designed to supply zinc, manganese, silver and other metals essential to the energy transition. With a focus on maximising performance while minimising environmental impact, Hermosa is being engineered as a best-practice critical minerals operation. This made the Jameson Concentrator's compact footprint and energy efficiency the first key factor in its selection.

With limited surface space, the Jameson Concentrator configuration reduced the flotation circuit from an alternative of approximately 22 conventional flotation cells to just 11 Jameson Cells, requiring only around 60% of the footprint. Glencore Technology projections also indicate energy savings of approximately 30% compared to a conventional tank cell circuit, reducing both operating costs and carbon emissions.

A second consideration was Hermosa's focus on automation and remote operation. The processing plant will be operated remotely from Centro, South32's operations centre in the nearby city of Nogales.

"When you're designing a mine around automation and remote operation, fast process feedback and reliable data become essential," commented Scott Martin, Glencore Technology's Sales Director, Americas.

"The Jameson Concentrator is particularly well suited to this environment. With residence times of just five to ten minutes, compared to 40-60 minutes for conventional flotation circuits, operators can see the impact of process changes much sooner. That enables faster optimisation, more frequent control actions, and creates a strong foundation for advanced process control and future AI-driven operation."

Operational flexibility was another factor influencing South32's selection.

"One of the advantages of the Jameson Cell is that it gives operators options," said Martin. "As ore characteristics change, individual cells can be reassigned to different duties, allowing the circuit to adapt without major modifications. That's an important capability for a project designed to operate for decades, especially one operated remotely."

By allowing cells to switch between roughing and cleaning duties, the circuit can be continually optimised as feed characteristics evolve throughout the life of the mine.

Together, the advantages of smaller footprint, lower energy consumption, automation readiness

and operational flexibility, made the Jameson Concentrator a natural fit for Hermosa's long-term vision.

Hermosa provides a glimpse into how future mines will be designed and operated. In selecting the Jameson Concentrator, South32 has demonstrated that the next generation of mineral processing will be defined not only by recovery, but by technologies that enable smarter, simpler and more sustainable operations.

Glencore Technology's Jameson Cell also continues to deliver against its performance objectives at Valterra Platinum's Mogalakwena North Concentrator, with the operation reporting further mass pull improvements alongside higher concentrator recoveries.

The latest results build on the successful commissioning of four Jameson Cells at the concentrator, replacing 40 conventional flotation units. The installation supports Valterra Platinum's low mass pull strategy. It produces a higher-grade concentrate at lower volumes, reducing downstream processing, materials handling and logistics requirements.

In its interim results for the six months ended 30 June 2026, Valterra Platinum reported that the technology delivered the full mass pull benefits anticipated in the original investment case while also providing a measurable recovery improvement.

Valterra Platinum CEO Craig Miller said the company's focus on operational optimisation had led to: "a 15% year-on-year improvement in mass pull and improved concentrator recoveries at the Mogalakwena North Concentrator following the implementation of Jameson cells."

Since commissioning, the project has reduced concentrate production by approximately 90,900 tonnes. The lower concentrate volume has delivered reported cost savings of ZAR203 million, reduced smelter electricity use by 70.5 million kWh and avoided approximately 73,000 t of emissions. It has also removed the need for around 2,600 concentrate truck movements.

These results demonstrate how the Jameson Cell can improve overall processing performance beyond the flotation circuit. By increasing selectivity and reducing the volume of material sent downstream, the technology lowers the processing, energy and transport burden associated with each tonne of valuable concentrate.

Valterra Platinum also highlighted the broader sustainability benefits of the technology in their interim results report:

"The deployment of Jameson cell flotation technology enhances processing efficiency by improving mineral recovery while reducing energy consumption and reagent use. Its compact design enables

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lower water usage per tonne processed and reduces the overall environmental footprint of concentrator operations, supporting both cost efficiency and more sustainable resource use.”

The results at Mogalakwena North continue to demonstrate the value of Jameson Cell technology. Across PGM and other mineral processing applications, it can improve recovery, reduce downstream volumes and lower environmental impacts without increasing circuit size or complexity.

Smart reagent formulations

Mineral processing intelligence is growing in capability and influence, and the flotation reagent sector is part of this. **Syensqo** has been one of the companies leading this charge with solutions like its Syensqo Cube, a state-of-the-art dosing equipment system that enables more precise blending and dosing control of reagent building-block chemicals during mineral processing trials; and SmartFloat®, a digital platform that empowers mine operators to boost flotation performance through real-time recommendations for reagent optimisation. **IM** had the chance to catch up with Keith Cramer, Syensqo Mining Solutions Technical Service Director to discuss this and other smart mining chemistry solutions already available and in the planning.

Cramer: “There’s increasing interest in what can we do with data and digital tools and that is across the different market areas that we’re in as well as the different customer bases. But the level of engagement varies – SmartFloat®, which represents the full ambition, being flexible chemistry control at a flotation plant in real time - relies on a lot of different things to work properly and in some ways is ahead of its time. While the different components exist, and we have learned a lot from trials and pilots, we have never implemented a full system. Full online control requires the right data on up to the minute mineralogical conditions on what’s getting fed into the circuit to be able to do the modelling and reagent composition adjustment in real time – we don’t have the mineralogy data to the level we need today. Plus ensuring data security is also an important aspect of success. But it is coming and it is already on the radar for customers that are already advancing with digitalisation plans and AI in the plant.”

Cramer said one of the things Syensqo is doing is breaking that journey up into some more concrete steps in the right direction. It has developed a solution called Flotation InSYght which takes some of the process data that is already available such as incoming ore chemistry, throughput, grind size, recovery rates and other variables., and provides analysis to be able to get some

recommendations out to the operation – not in real time but fast enough to still be able to make important changes where they will have significant benefit. It builds on what has and is already being achieved with SolvExtract®, which was launched in 2019 and was a first-of-its-kind digital platform that connects chemistry and operational insight to make solvent extraction more efficient. InSYght will apply similar technology to the flotation circuit.

Noting SolvExtract® successes, a copper SX operation in the US that was experiencing an intermittent loss in Cu recovery from the operation in North America. When looking into performance variation at the plant through SolvExtract®, the team noticed the stage efficiency drop. Investigating more, they then noticed the mixing condition changes, and then worked with the customer to optimise the conditions and improve Cu recovery. By having a stronger connection to the data from the customer operation the team could more quickly recognise the issue, identify the root cause and come up with solutions – issues that Syensqo says would normally get lost in the day-to-day issues at the plant.

Cramer: “It’s helping improve that connection to the customer and the data that they’re getting from their plant so that we can provide more effective technical service for the plant. It is also helping us automate that analysis to a greater degree.” InSYght is still in development but will be rolled out with some key customer locations in the next 12-18 months.

In terms of Syensqo Cube, as this is based on trials, it is much more flexible but still has an importance role, as this type of analysis work is much easier at a demo or lab scale



Syensqo Transfoamer frothers are based on a novel technology that changes froth strength in response to pH, leading to more efficient copper recovery

than in the dynamic nature of a working process plant. Cramer: “The value of the Cube means we are no longer limiting ourselves to one formula or two formulas that we’ve developed in the lab around initial ore testing. We are able to take into account variable plant conditions and make corresponding formulation adjustments, understanding how we can optimise parameters in the real plant to roll out a more effective, more robust reagent solution for the customer. It is also relatively portable – consisting of small pump units – so we have it running in different mining regions and are able to move it between different customers in those regions as required.”

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Syensqo has another important element to its digital reagent formulation toolbox – MINCHEM™, an advanced modelling tool designed for optimising solvent extraction operations. It enables mines to simulate circuit parameters and reagent requirements in a matter of seconds, facilitating faster optimisation of existing plants and quicker start-ups of new plants. Cramer: “This is an advanced engine for solvent extraction circuits. We can analyse how a plant is performing versus expectations to build recommendations, but we can also model different configuration conditions for reagents to evaluate what-if scenarios.”

MINCHEM™ was specifically designed for solvent extraction operations focused on copper modelling with ACORGA extractants. Its main objective is to optimise existing circuits or evaluate future circuit conditions. With a long legacy dating back to its first release in the 1980s, MINCHEM™ has been a trusted tool in the mining industry for decades. In 2018, MINCHEM™ was upgraded to become the advanced modelling tool behind SolvExtract. MINCHEM™+ extended the capabilities of MINCHEM™ beyond copper, using CYANEX and DEHPA modelling to support the design of new mines and more complex SX circuits for battery metals. These capabilities have been further enhanced via a full redesign to allow computation of reagent requirements and plant parameters in a matter of seconds or minutes.

With a number of new flotation cell innovations appearing – this month’s coverage of Metso’s new Sampo coarse particle flotation cell being a case in point – **IM** also discussed the development of specific reagents for this part of the market. Esau Arinaitwe, Mineral Processing R&I Manager at Syensqo commented: “The flotation equipment industry, once dominated by conventional mechanical cells, is increasingly embracing more specialised devices that operate in new hydrodynamic regimes engineered to overcome the physical limitations of poor fine and coarse particle recovery. In our experience working with these new devices, we have observed that flotation reagents need to be tailored to the new operating regimes in order to obtain step-change improvements in overall process performance. Thus, in parallel with advances in flotation equipment, we are developing next-generation reagent technologies specifically designed to improve recovery of ultrafine, fine, and coarse particles by optimising the surface chemistry aspects of sub-processes that are critical to maximising performance of the new devices. We are currently advancing scale-up trials for new AERO® collector formulations designed to address these challenges, while continuing to rollout our

TRANSFOAMER™ frother technologies to promote coarse particle recovery and overall metal recovery without adversely impacting downstream operations.”

As an example, at a copper-moly operation in the southwest US, implementation of TRANSFOAMER™ T-200 frother resulted in increased rougher mass pull which improved overall metallurgical recovery while mitigating downstream overfrothing that had historically constrained plant performance.

BGRIMM-MAT’s microfine-particle flotation patent builds on proven commercial uptake in China

Chinese flotation technology leader **BGRIMM Machinery and Automation Technology Co Ltd** (BGRIMM-MAT) told **IM** that it has reinforced its position in fine-particle (≤ 0.03 mm in general) mineral processing with a newly disclosed Chinese patent and several technical innovation awards related to fine-size flotation. BGRIMM-MAT Senior Sales Engineer Gabrielle Yu: “The WXF flotation cell technology addresses a persistent industry challenge: as mineral resources become finer-grained, conventional flotation cells can suffer from weaker particle-bubble collision efficiency, lower recoveries, and more difficult froth handling. The equipment applies high-intensity, locally constrained turbulence; staged air dispersion; and an optimised froth-removal arrangement.”

She adds: “Rather than simply increasing energy input, the design makes better use of energy in the zone where bubble-particle collision and attachment occur. In theoretical terms, the defining characteristics of the equipment are micro-bubbles, high turbulence, and low cross-sectional load. This distinction is central to recovering difficult ultrafine fractions while keeping froth transport manageable.”



The new BGRIMM-MAT WXF flotation cell

The structure of the WXF flotation cell is shown in the attached image, highlighting its unique tank-body and agitator-system design. The flotation machine offers a complete range of specifications from 2 m³ to 70 m³ for large-scale industrial use. Each model has undergone rigorous mineral-processing tests and industrial commissioning, and its performance parameters are highly stable.

Yu says market traction is already established. According to an official achievement disclosure by the State-owned Assets Supervision and Administration Commission (SASAC), BGRIMM-MAT’s microfine-particle mineral recovery equipment has been applied in microfine phosphate, fluorite, and sulphur recovery projects in China, with a cumulative installed base of 172 units. The disclosure also confirms that the equipment integrates four patent achievements and is designed for strong process adaptability, high recovery, and reliable mechanical performance.

BGRIMM-MAT’s commercial proposition is supported by a demonstration project for the beneficiation and recovery of fine-grained ilmenite at the Piao Shuiya Processing Plant in Sichuan province, China. The mill produces 1.2 Mt of iron concentrate annually; its tailings (P90 = 0.025 mm) are sent to the Piaoxiaoyan Processing Plant for titanium recovery, at a productivity of approximately 700 t of titanium concentrate per day, with about 650,000 t of fine-grained titaniferous iron ore previously lost in the tailings.

Following the introduction of BGRIMM WXF flotation cells, the plant achieved efficient recovery of fine-grained minerals from feed ore characterised by a nominal particle size of approximately 0.025 mm – thereby raising the overall mineral recovery rate to 80% and elevating the titanium grade in the concentrate to 43%. The upgrade delivered substantial economic benefits.

Yu: “The results demonstrate that constrained, high-turbulence energy input can convert difficult ultrafine feeds into saleable concentrates. They are not, however, presented as guaranteed plant outcomes: actual performance remains ore-specific and dependent on feed characteristics, circuit configuration, and operating practice.”

For project owners and engineering partners, the business case rests on three points: proven deployment across multiple fine-particle mineral applications in China; a growing installed base; and a technology path that targets recovery of material traditionally lost in fine tailings.

BGRIMM-MAT adds that it offers equipment supply, process development, and project-specific testing to support adoption.

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