Flowsheet improvements for the real world

JAMESON CELL

ISAMILL™

JAMESON CONCENTRATOR

ALBION PROCESS™

GLENCORE TECHNOLOGY

A GLENCORE COMPANY

Jameson Cell flotation gives you more concentrate per dollar, per metre and per year

> The Mount Isa Copper Concentrator has operated two Jameson Cells in pre-flotation and slag cleaner duties, very successfully, for over 15 years. In 2015 we installed three 18 downcomer Jameson Cells to replace the cleaner circuit. We've seen significant improvements in operability and maintenance intensity translating to improved recovery at a reduced cost."
>
> – Mount Isa Copper Concentrator, Mount Isa Mines

Jameson Cell at a glance

- → Real-world success in 431 installations across 30 countries since launching in 1988
- → It creates the smallest bubbles of any flotation cell, to deliver the best grade and recovery
- → No moving parts for maximum availability and easy maintenance
- → Strongest performance guarantee in the world
- → 100% scale-up reliability
- → Smallest footprint delivering the largest amount of concentrate

JAMESON CELL

For more:
jamesoncell@glencore.com.au
Tel +61 7 3833 8500

Jameson Cell is the most effective froth flotation technology in the world and the reason is in the bubbles

The Jameson Cell creates smaller bubbles than any other flotation cell, so it creates more surface area for the particles to collide with and attach to. Jameson Cell Flotation gives you more concentrate per dollar, year after year.

Jameson Cell has been used and proven in base and precious metals, coal, industrial minerals, oil sands and solvent extraction. There are 431 Jameson Cells installed around the world.

The Jameson Cell has no moving parts, so it delivers reliable froth flotation with a promise of 99% availability. It's so predictable that it's guaranteed to deliver 100% scale-up performance, across all applications.

The Jameson Cell has the smallest footprint and unlike conventional cells does not need a long residence time. The Cell's downcomer sees feed pumped under high pressure to shear and entrain air from the atmosphere into fine bubbles. Particle to bubble interaction happens immediately in the downcomers high shear mixing zone.

Jameson Cell designs are flexible so they're ideal for any new project and a great option for low cost plant expansions. They're easy to install and can be delivered in modular sections for easier transport and faster installation. Once commissioned, they are very easy to operate, deliver excellent availability and are simple to maintain.

The inclusion of a recycle mechanism means the Jameson Cell is also very tolerant of feed variations, so they're made for the real world.

Glencore Technology provides accurate Jameson Cell design and scale up, engineering, manufacturing, flotation circuit design and review, installation support, cell commissioning and ongoing technical support.

A Jameson Cell is the most risk-mitigating and reliable froth flotation system you could buy.

How Jameson Cell delivers more concentrate and reduces risk for your project

1. More accurate scale-up

The Jameson Cell is proven in the real world. The hydrodynamics for particle collection inside the Jameson Cell are identical between laboratory, pilot plant and full scale Jameson Cells, so scale up is direct, proven and guaranteed.

For that reason, choosing a Jameson Cell for your flowsheet significantly reduces project risk. When you choose a Jameson Cell, the scope includes process and design, supply and commissioning by experts with real-world experience, for easy installation by a local contractor or EPCM.

2. Easier installation

There are no rotors, compressors or blowers to install, operate or maintain. There are no moving parts in the cell, and the only other equipment is a feed pump, so the Jameson Cell is quick and simple to install.

Your Jameson Cell undergoes a full trial assembly prior to delivery to your site. All the parts fit perfectly together during plant installation, making the whole process straightforward.

3. Simple operation and rugged tolerances

After installation, start up and commissioning is even simpler – it only needs the feed pump to operate to the designed flow and pressure. Commissioning is simple and the cell will reach design capacity quickly.

Your Jameson Cell will be sized to accommodate the design flowrate based on the number of downcomers. The tank can be designed to fit into restricted spaces, making it ideal for retrofits/replacement and expansion projects. The construction materials are flexible and your cell can be fabricated to suit your application.

4. Smaller bubbles and more concentrate

The Jameson is a step change in flotation efficiency. Feed is pumped into the downcomer, creating a high-pressure jet that entrains air. That aerated jet plunges into the slurry, where the kinetic energy of impact breaks the air into fine bubbles which collide with the particles, carrying them into the froth phase.

Those bubbles are smaller than other flotation systems, creating more surface area for the particles to attach to.

The rapid kinetics mean the Jameson Cell simply needs contact and not residence time, so it's much smaller than equivalent mechanical and column cells and fewer units are required.

The grade of the concentrate is controlled by froth drainage and froth washing. Your Jameson Cell ensures an efficient, quiescent zone that maximises froth recovery, and is perfect for froth washing. The high carrying capacities mean you can process large tonnages in a small volume.

5. Easier operation and maintenance

Your Jameson Cell quickly reaches equilibrium and can continue operating if feed supply is interrupted.

Automatic tailings recycle eliminates fluctuating feed flow, to give you constant flow, consistent performance and a simple start-up.

The cell operates at a constant feed pressure and the hydrodynamic action inside the downcomer, essential for particle collection, is always consistent.

Maintenance is rare and simple. The highest wear component, the slurry lens orifice, has a wear life of more than five years! Downcomer maintenance can be performed while the cell is operating and takes less than 10 minutes.

How we help you get more from your Jameson Cell

Commitment in a partnership

The Jameson Cell was developed and proven in real world mining applications, so we've built up a suite of services in a Technology Partnership concept.

As a Partner:

- You will have access to training and learning opportunities at real client sites.
- You will always have access to our most experienced technology experts around the world.
- Your team will have opportunities to learn from other users.
- You will have access to service and parts help.
- You will secure an ongoing technical relationship with us.

A strong performance guarantee

Jameson Cell Flotation gives you more concentrate per dollar, year after year.

The commitment and agreement is complete:

- The lab results will scale up, with 100% accuracy.
- Your Jameson Cell will perform at a minimum of 99% availability.
- We will work with you to ensure your needs for feed variability, operations and maintenance will be built in.
- Training and support will be included.

Examples of how others have gained from their Jameson Cell

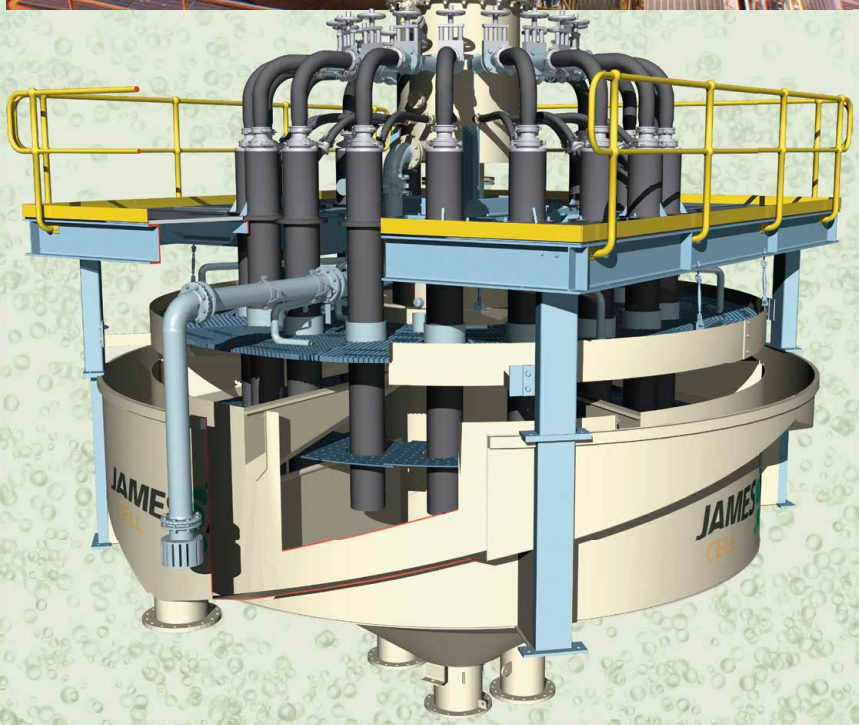
More concentrate, less energy and a broad range of applications

A set of just twelve Jameson Cells at Curragh (Australia) treats over 5 Mtpa of coal fines. Jameson Cells are also installed in coal operations in Africa, North America, Asia and Europe.

A retrofit Jameson Cell at Mount Isa achieved energy savings of up to 76% when it replaced 16 mechanical cells with one Jameson Cell.

The biggest operating cell, a J7250/10 recovering organics from 3000 m^3 per hour of raffinate at Olympic Dam's copper SX plant in Australia, was commissioned in 2003.

There are 431 Jameson Cells operating around the world.



IsaMill™ uses horizontal milling to secure better energy efficiency, product size and availability

> IsaMill's horizontal configuration means it's completely different from other mills. IsaMill™ gives me an increased recovery that outweighs the cost. I never have to worry about the mill."
>
> – Amandelbult Operation, Anglo American

IsaMill™ at a glance

- → Real-world success in 144 metalliferous installations across 23 countries since launching in 1994
- → World's only horizontal fine grinding mill, it avoids short-circuits and gives the highest availability
- → Most efficient fine grinding mill in the world
- → Strongest performance guarantee in the world
- → Most consistent product size
- → Delivers better results to downstream flotation and leaching
- → The new smaller footprint makes the IsaMill™ equivalent in total area footprint to vertical mills

ISAMILL™

For more:
isamill@glencore.com.au
Tel +61 7 3833 8500

IsaMill™ is the most efficient and reliable grinding mill available and with 144 metalliferous installations in 23 countries it has a proven record in the real world

The IsaMill™ reduces the energy, media and capital costs of grinding. It's incredibly efficient and intense. It focuses only on the particles that need grinding.

The IsaMill™ has a greater power intensity than ball or tower mills and takes feeds as high as 400 microns and delivers a product as low as 5 microns.

Today's IsaMill™ also has a very small footprint. A modest volume of concrete and structural steel are used, and the entire unit sits on a one-storey platform. This means it's about a third the height and weight of similar grinding mills available.

It produces the most consistent and 'sharp' particle size distribution in a simple open circuit configuration.

IsaMill™ is the world's only horizontal fine grinding mill. The horizontal slurry flow means low cost ceramic media can be used without the concerns of a vertical mill. It's easy to operate and it maximises availability.

The horizontal nature of the IsaMill™ also means it is far safer than other mills and there is no working at heights required.

The IsaMill™ gives an accurate and rapid scale up, so it's predictable and reliable.

Operating and maintaining the IsaMill™ is safe, simple and reliable. It's quick to install, flexible in operation and easy to maintain.

The IsaMill™ is widely used in base metals (copper, lead, zinc and nickel), PGM, iron ore, industrial applications and gold processing plants and is the best choice for regrinding concentrates, fine or ultrafine grinding and mainstream grinding.

The IsaMill™ is currently available in the following models, named for their net grinding volume:

- M1000 (355–500kW)*
- M3000 (800kW)
- M5000 (1120–1500kW)
- M7500 (2200kW)
- M10000 (3000kW)
- M15000 (3700kW)
- M20000 (5000kW)
- M30000 (6000kW)
- M50000 (8000kW).

* Smaller models are available on request

How IsaMill™ grinds more efficiently and delivers greater value

1. More accurate scale-up

The IsaMill™ is proven in the real world. Lab and pilot results are scaled to commercial size with 100% accuracy. We test rigorously for specific energy, particle size and optimise the media size for accurate scale up so that every plant we install always meets design.

When you buy an IsaMill™, the scope includes process and engineering design, supply and commissioning by experts with real-world experience, for easy installation by a local contractor or EPCM.

2. Easier installation and operation

Because the IsaMill™ delivers high intensity grinding, it only requires a small footprint.

The horizontal configuration results in a low height, unlike vertical grinding mills. Smaller cranes are required to install and maintain the IsaMill™.

The IsaMill™ takes about a tenth the grinding volume of an equivalent ball or tower mill. There are no external screens or cyclones required because the IsaMill™ internally classifies the feed and delivers a consistent product.

3. Finer grinding and better media

Slurry travels in a 'plug' flow pattern through the eight rotating grinding discs within the mill. Media recirculates between the discs, colliding with the particles in the feed, causing breakage.

The media is ceramic and avoids the passivation of particles common with metallic media, improving the product for flotation and leaching.

The IsaMill™ delivers an even blend of attrition and abrasion of particles throughout the mill. At the discharge end, slurry and media reach a patented product separator where media and over-sized particles are retained in the grinding zone, while particles at the correct grind size exit the IsaMill™.

4. Most consistent product

The IsaMill™ gives a sharper product size distribution. Other mills with just one grinding stage require closed circuit cyclones and high recirculating loads and still don't produce product size distributions as tight and steep as the IsaMill™.

The IsaMill™ also produces clean, fresh mineral surfaces that improve downstream performance from flotation and leaching.

5. Easier operation and maintenance

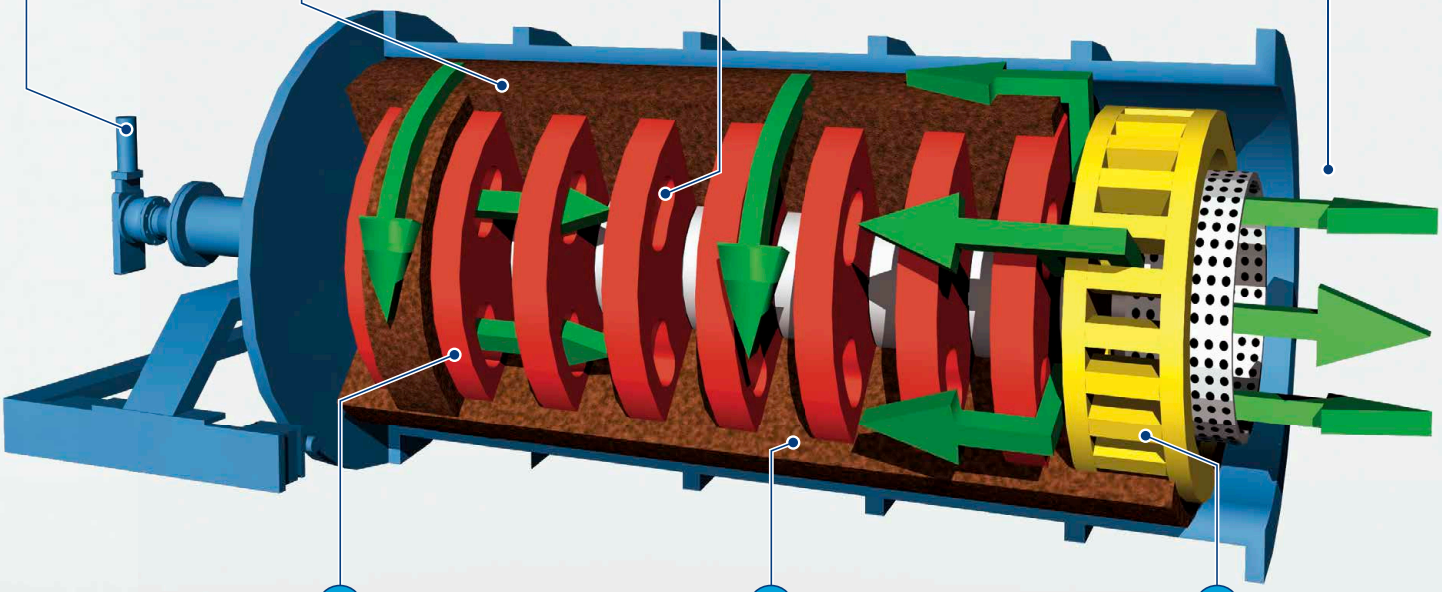
The IsaMill™ can be started under load so no time is lost in draining the mill.

Maintenance is easy. The entire grinding chamber is quick to access. Slurry is flushed from the IsaMill™ and the media is dumped through a scuttle valve into a hopper below. The IsaMill™ shell is then pushed back along rails using hydraulic rams, giving you quick access to all the wear parts, all in under half an hour.

Even a complete shutdown for inspection and replacement of wear parts including the liner itself takes less than eight hours.

A lot happens inside a small space

1. Pumped slurry enters mill at around 50–150 kPa
2. Inside the mill, grinding discs attached to the shaft are rotating at tip speeds around 20 m/s resulting in high intensity mixing
3. In addition to slurry, the mill is 75% filled with small ceramic grinding beads (depending on the power draw the mill is run at)
4. The high centrifugal forces in the mill force the media and coarse particles to the outside of the mill where the coarse particles are ground down
5. The finer particles not requiring grinding move quickly through the holes in the grinding discs towards the discharge
6. At the end of the mill, particles are classified internally by the rotating product separator and the coarse particles are forced back into the grinding chamber
7. Fine particles discharge the mill and move to further processing



How we help you get more from your IsaMill™

Commitment in a partnership

The IsaMill™ was developed and proven in real world mining applications, so we've built up a suite of services that underpin our Technology Partnership concept.

As a Partner:

- You will have access to training opportunities at real client sites.
- You will always have access to our most experienced technology experts around the world.
- Your team will have opportunities to learn from other users.
- You will have access to a comprehensive spare parts supply.
- You'll have access to maintenance and advisory services.
- You will secure an ongoing technical relationship with us.

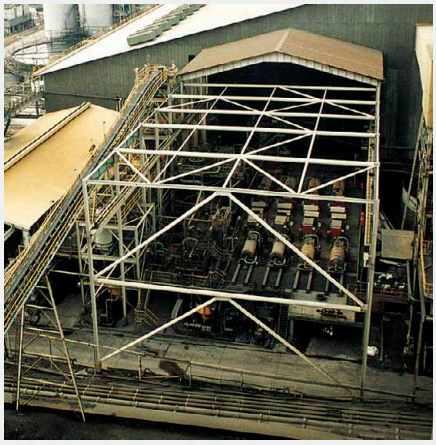
A strong performance guarantee

IsaMill™ uses horizontal milling to secure better energy efficiency, product size and availability.

The commitment and agreement is complete:

- Your needs for a given energy draw or a given product distribution will be secured by the performance guarantee.
- We will work with you to ensure your needs for feed variability, operations and maintenance will be built in.
- Training and support will be included.

How others have gained from IsaMill™



George Fisher's regrind circuit boosts recovery and reduces reagents

When Mount Isa Mines commenced the George Fisher Project in 1999, they recognised they needed to expand their fine grinding capabilities with additional IsaMills™.

Every one-micron size reduction in the zinc retreatment circuit below a P80 of 10 microns improves the overall plant zinc recovery by 1%, and the IsaMill™ was modelled to achieve this.

Eight 1.1 MW IsaMill™ installations were introduced, two to regrind lead cleaner feed and six to regrind intermediate zinc flotation streams. The existing concentrator was modified to suit the new ore type.

The results were good and better – the recovery improvement was expected due to better liberation, but the operation also saw a significant drop in reagents and circulating loads.

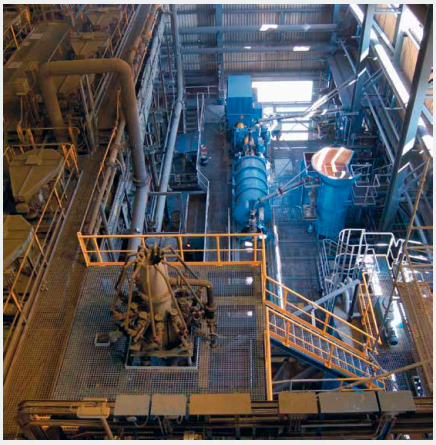
Fine minerals are expected to consume more reagent due to their higher surface area, but improved liberation dropped circulating loads. Clean fresh surfaces from inert attrition increased flotation rates and selectivity, and these significantly reduced the need for collector and depressant.

Prominent Hill uses IsaMill™ and Jameson Cell to boost downstream performance

OzMinerals' Prominent Hill copper-gold concentrator began commercial production in 2009. They needed liberated fluorine minerals to be rejected in the cleaner flotation circuit to produce a commercial quality copper-gold concentrate.

A 3 MW M10000 IsaMill™ operating with 3.5mm ceramic media was installed to liberate the fluorine bearing gangue minerals from the rougher concentrate.

The IsaMill™ regrind circuit successfully produced a leaner circuit feed P80 of 20–25µm ensuring adequate liberation. What's more, the inert grinding environment in the IsaMill™ prevented contamination of the mineral surfaces and gave OzMinerals the optimum flotation performance from the first day of commissioning.



144 metalliferous installations in 23 Countries

Clients and Projects include:

- Coal – Corbin (ARQ)
- Magnetite – Liberty (SIMEC)
- Copper – Constancia (Hudbay)
- Zinc – Red Dog (Teck Resources)
- Lead – Mount Isa Mines (Glencore)
- PGM – Mogalakwena (Anglo American)
- Gold – Gidji Roaster (KCGM)
- Climax Molybdenum – Climax Molybdenum (Freeport McMoran)
- Nickel – Cosmos (Western Areas)
- Tin – San Rafael B2 Project (Minsur)

Jameson Concentrator delivers more concentrate from less footprint, less capital and operating cost, using less energy

> The Jameson Concentrator will reduce the flotation machines in Ozernoye from 63 to just 19, or by about two thirds. But it'll process the same 875 tph. This combination of performance and efficiency is important to us and to the mining future, considering the depletion of the mineral resource base."
>
> – Alexandr Kanarskiy
> *Chief Metallurgist, Ozernoye*

Jameson Concentrator at a glance

- → Processes the same throughput for a smaller footprint
- → Treats lower grade and complex ores cheaper and more efficiently
- → Significantly smaller CapEx and OpEx and energy costs
- → Less downtime, less maintenance
- → Easily constructed by an EPCM to go-live quickly

JAMESON CONCENTRATOR

For more:
glencoretechnology@glencore.com.au
Tel +61 7 3833 8500

Jameson Concentrator is the most efficient concentrator in the world – it delivers full-circuit capabilities from the most compact, simple and reliable flotation technology

Because mines increasingly have to go deeper, and into lower grade and more complex ores, operations need more efficient concentrators. The Jameson Concentrator takes new generation Jameson Cell and IsaMill™ technology to deliver a complete concentrator plant in the smallest footprint in the industry.

The Jameson Concentrator helps you solve the conflict between higher performance expectations and lower quality of ore bodies.

The Jameson Concentrator combines various configurations of Jameson Cell, modified and proven to process even larger volumes, and can add new generation small-footprint IsaMill™ technology where greater and precise liberation is needed.

The concentrator can process the same or greater throughputs with less equipment and less energy input – while producing exceptional metallurgical performance even from challenging orebodies.

This state-of-the-art full circuit concentrator is based on industry learnings from over 144 IsaMill™ and 431 Jameson Cell installations across 30 years.

The Jameson Concentrator offers the following game changing benefits:

- Low profile, small footprint plant layout
- Up to 60% footprint reduction for significant CAPEX savings
- From 30–60% of the energy of a conventional flotation circuit
- Significant reduction in moving parts and subsequent operating costs
- Faster, easier and cheaper maintenance, more availability
- Cell by-pass ability meaning high circuit availability
- No agitators, rotors or blowers in flotation and highly efficient grinding results in significantly lower power consumption
- Significantly greater and faster returns for treating lower grade ores and higher throughputs
- Circuit and equipment operational simplicity for consistently high performance
- Our flotation and milling technologies can be configured flexibly by an EPCM to deliver a custom concentrator from proven technology.

How Jameson Concentrator's core technologies work to deliver more for less

Jameson Cell

- High intensity, efficient flotation.
- Maximised metallurgical performance – demonstrated recovery increases of up to 6%.
- Quick & efficient particle-bubble Interaction – no short-circuiting.
- Reduction in residence time.
- Integrated wash water – upgrade equivalent to three stages of mechanical cell cleaning.
- Produce high grade concentrates.
- Proven performance across a wide range of size fractions, including coarse and ultra-fines.
- Scale-up directly 1:1 from lab-scale float results with high accuracy.
- Widely used across coal, precious and base metals, potash, and oil sands.

IsaMill™

- High energy efficiency grinding.
- Tight product size distributions.
- Enabling technology for any ores with F80 of up to 400µm and delivering a P80 down to 5µm
- Downstream processing benefits from using inert media.
- Grinding media only 10–70% of the cost versus vertical-style high SG mill media.
- Allows smaller, more efficient, higher grade/recovery circuits.
- Low profile meaning easier and safer operation and maintenance.

Product Range Development

- Recent release of additional models to both the IsaMill™ and Jameson Cell technologies.
- Expansion of range covers higher throughput requirements as new or existing mines treat lower grade – higher volume deposits.
- Products offered from single unit optimisation/expansion/ debottlenecking projects for existing sites through to full circuit solutions.

Examples

- **Philex operation, 1996.** Ten Jameson Cells replaced 50 conventional cells to treat 900 tph of copper and gold and saw up to a 4% increase in recovery.
- **Hubay's New Britannia operation** is currently completing an installation that sees four Jameson Cells replace the planned 11 conventional cells. Commissioning Q3 20. EPCM is AECOM.
- **Ozernoye operation** has gone into execution with 19 Jameson Cells replacing what would have been 63 tank cells. Three new M20,000 IsaMill™ with 5 MW motors will deliver greater liberation. The footprint reduction is over 50%. Commissioning Q4 2022. EPCM is Engineering Dobersek.

Customisable flowsheets deployable by EPCMs

- Jameson Cell and IsaMill™ are highly customisable to suit any flowsheet requirement of a concentrator.
- The two technologies can be adapted by an operation or EPCM to suit the particular needs of the flowsheet.
- Models and in-depth specifications can be made available to EPCMs after an on-boarding program.
- Glencore Technology works with EPCMs on every continent to deliver an operation exactly what it needs.

Albion Process™ leaches the broadest feed variations, costs less and ramps-up faster

> Albion Process™ exceeded expectations. Even with large swings in sulphur grade and feed rate, we maintain gold recovery in the cyanidation plant above design targets. Without Albion Process™ we would only achieve around 20% gold recovery and huge cyanide consumption, but with Albion Process™ we can achieve over 95% gold recovery and minimal cyanide consumption, giving the process plant outstanding return on investment."
>
> – GPM Gold

Albion Process™ at a glance

- → Real-world success in delivering over 99% leach recovery
- → Replaces large complex high cost-capital assets with simple low cost capital assets
- → Tolerates a broader low grade more variable content feed and works where others fail
- → Incredibly fast and simple to commission and operate
- → Modular so it can be implemented in stages but maintain economic performance
- → Strongest performance guarantee in the world

ALBION PROCESS™

For more:
albionprocess@glencore.com.au
Tel +61 7 3833 8500

Albion Process™ combines fine-grinding and oxidative leaching to create a hydrometallurgical asset that works where others fail

The Albion Process™ is a proven atmospheric oxidative leaching process for base and precious metals that is reliable, safe and highly favourable economically.

The Albion Process™ is a proven atmospheric oxidative leaching process for base and precious metals that is reliable, safe and highly favourable economically.

Albion Process™ has real-world success in delivering over 99% leach recovery and creating significant downstream cost savings.

The process comprises two main steps for efficient recovery of valuable metals. The first step is mechanical liberation using an IsaMill™ to grind the Albion Process™ feed particles to a narrow size distribution. This prevents passivation of the mineral surfaces in the subsequent oxidative leaching step.

The second step is chemical liberation achieved by injecting supersonic oxygen into the base of a series of Albion Process™ Leach Reactors continuously fed with the ground concentrate. Oxygen is injected using the HyperSparge™ supersonic oxygen injection system to maximise oxygen mass transfer and drive the oxidative leaching reactions.

Albion Process™ has significant capital and operating cost advantages because the process oxidises as much of the sulphide as you need but as little as possible to achieve the target metal recovery in either acid or neutral systems. This means a small oxygen demand and a smaller leaching train.

The Albion Process™ operates under acid or neutral conditions.

Acid conditions are used for treating base metal concentrates. Metal species like copper are recovered by first dissolving them into solution.

Many metal compounds can be oxidised and leached into solution simultaneously making it suitable for polymetallic feeds of base and precious metals or complex feeds. This means a high grade concentrate is not required for feeding Albion Process™ and the upstream concentrator can operate in a simpler circuit configuration at a point on the grade-recovery curve that maximises global metals recovery.

Neutral conditions are used for treating iron sulphide concentrates where metal species are recovered by a downstream process after oxidation of the concentrate, such as gold in a cyanidation process.

By operating at near neutral conditions for iron sulphide oxidation, elemental sulphur is not generated. This adds more value to the downstream process as cyanide consumption is significantly lower compared to pressure oxidative leaching (POx) or bacterial leaching which operate under acidic conditions.

The Albion Process™ tolerates an incredibly broad feed variance. Throughput and sulphur content can vary significantly, as most real-world operations do, without causing a process interruption.

The result is the world's most proven and reliable leaching system delivered, operating in a simple, robust and easy to commission package.

The capital investment required for the Albion Process™ are roughly half the cost of traditional leaching processes.

Traditional and alternative leaching systems can be expensive or high-risk to operate and maintain. The Albion Process™ is simple and safe. It's also the fastest leaching process to install, and has taken as little as six weeks to commission and begin operating at design recovery and throughput rates.

The Albion Process™ is ideal for precious and base metal concentrates. It can boost recoveries for zinc, copper, molybdenum, cobalt, nickel, lead, platinum group metals (PGMs), and refractory silver and gold.

How Albion Process™ delivers better returns and reduces risk for your project

1. Accurate modelling means less risk

Your Albion Process™ plant is developed in three stages, from the laboratory to full-scale, to ensure it will deliver design throughput and plant recoveries.

- **Go/No-go:** A single batch test determines amenability of the process to your feed material and allows us to gather key design data.
- **Optimisation:** Optimisation of grind size, residence time and operating density to ensure the correct IsaMill™ size is selected.
- **Variability and parameterisation:** Batch testing of variability samples under optimised conditions ensures that the flowsheet will treat the wide variety of feeds encountered in the real operation.

2. Significantly less expensive and easier to install

The capital equipment required in the Albion Process™ is considerably less than what's needed in alternative leaching processes.

It's about half the cost of a traditional POx or bacterial leaching system.

The Albion Process™ doesn't need pressure and so it doesn't represent a risk of catastrophic failure or require the consequential rigorous statutory checking. The ZipaTanks™ are modular and fast to erect.

In fact, the commissioning process is incredibly fast. The IsaMill™ is considerably easier to install than a large high intensity mill, taking as little as four weeks on site. At the same time, the Albion Process™ Leach Reactors can be commissioned. The result is that it's taken as little as one team member six weeks to commission Albion Process™ and get operating.

3. Easy to learn and on-board

As we install your Albion Process™ plant, we begin a thorough technology transfer with our technology experts, metallurgists and maintenance experts and we train your team at your site before, during and after commissioning.

- **First**, you'll have access to fully operational Albion Process™ sites during the construction process to help your operators be trained and prepared before your plant is commissioned.
- **Second**, we deliver classroom training at your site towards the end of the construction period so your team can retain and use what they've learned. During this stage, site-specific operating procedures are developed between GT experts and site personnel.
- **Third**, your team are familiarised with the plant and begin working under our guidance at site until they're comfortable, usually for one or two weeks. We also remain in regular communication. This means your plant is enabled to ramp up as fast as possible and maintain performance.

4. Tolerates a broader feed variation

Ordinarily, maintaining conditions in oxidative leaching processes that maximise kinetics and leaching extent can be challenging because the feed grade and feed rate varies. This is because the sulphide minerals are the fuel to the oxidative leaching process. Variability in the sulphide grade, feed rate, or fuel input of the feed causes process interruptions or loss of efficiency in pressure or bacterial leaching.

However, the Albion Process™ is not affected by variations in feed quality and quantity provided the oxidation demand is kept within the capacity of the oxygen plant which is not difficult.

GPM Gold in Armenia has increased recovery of gold from refractory ore from 20% to over 95%, outperforming the design of 92%.

Even with the feed rate varying from 25–70 tonnes per hour, and sulphur varying from 8–35% the recovery was maintained at or above design gold recovery levels from the residue.

5. Easier to operate and maintain

Pressure leach reactors are the opposite of Albion Process™. They're complicated and higher-risk in operation and maintenance. They require a high level of monitoring to ensure the process remains within defined parameters to prevent the risks of catastrophic failure. The procedures for isolating and maintaining are very rigorous and in most countries the pressure vessel requires statutory checks. These additional procedures impact on plant availability reducing throughput capability.

Installing more than one autoclave is common due to rebricking requiring another autoclave as a means of delivering continuity. So the capital costs are high compared to Albion Process™.

Bacterial leaching requires many more tanks, is less tolerant of feed variations and requires maintenance of a low-pressure air injection system which can become blocked. It also requires additional capital over time to manage water quality to continue operation.

Albion Process™ doesn't have complicated equipment operating at high pressures. The equipment consists of low maintenance slurry pumps, agitators, valves, HyperSparges, tanks and thickeners. These items are basic in design and require non-specialised skills and procedures to operate and maintain and are all well understood. Even if the instrumentation fails on an Albion plant, generally the plant can keep running.

Albion Process™ comprises established, reliable and proven unit operations such as the IsaMill™, Albion Process™ Leach Reactors, HyperSparge™, pumps and thickeners. This means the process is flexible, simple, robust and reliable.

The most critical part of the Albion Process™ is the delivery and transfer of oxygen to where it is needed to drive the oxidation reactions in the Albion Process™ Leach Reactors. This is achieved through the specially designed oxygen mass transfer system in the Albion Process™ Leach Reactors. Oxygen is injected at super-sonic velocities through a set of HyperSparge™ lances into the Albion Process™ Leach Reactors. Process interruption is minimised because the HyperSparge™ units can be removed from the Albion Process™ Leach Reactors and inspected while the other HyperSparge™ units are operating and without scuttling leach reactors.

How we help you get more from Albion Process™

Commitment in a partnership

Albion Process™ was developed and proven in real world mining applications, so we've built up a suite of services in a Technology Partnership concept.

As a Partner:

- You will have access to training and learning opportunities at real client sites.
- You will always have access to our most experienced technology experts around the world.
- Your team will have opportunities to learn from other users.
- You will have access to service and parts help.
- You will secure an ongoing technical relationship with us.

A strong performance guarantee

Albion Process™ leaches the broadest feed variations, costs less and ramps-up faster to deliver better returns.

The commitment and agreement is complete:

- The expectations we outline will transpose to your application and Albion Process™ will achieve minimums specified.
- The Albion Process™ plant will be commissioned completely, including testing, training and attainment of minimums.
- Our assumptions of feed variances, appropriate operation and maintenance schedules will be clearly identified.
- Glencore Technology will respond to any problems or faults.

How others have gained from Albion Process™

GeoProMining Gold quadruple plant recovery

GeoProMining (GPM) successfully increased recovery from sulphide concentrates in their Ararat plant from 20% to over 95%, defying expectations and targets. The plant was commissioned in June 2014 and achieved full capacity after three months.

GPM own and operate the Zod Gold Mine and Ararat Processing Plant in Armenia to produce gold and silver bullion. In order to expand, GPM needed to treat the underlying sulphide material at the Zod mine which achieved around 20–30% gold recovery through their existing conventional Carbon in Leach (CIL) flowsheet.

In 2010, GPM approved a refurbishment project at the Zod Mine and Ararat Processing Plant – in increased crushing capacity to deal with the harder ore and a refurbishment and re-commissioning of the existing flotation plant.

They added to this the installation of a new Albion Process™ plant for the oxidation of the sulphide concentrate prior to its treatment in the existing CIL plant. The new flowsheet would be configured such that the CIL would treat flotation tailings and oxidised residue from the Albion Process™.

The design basis for the Albion Process™ at GPM was oxidation of 100,000 tpa of concentrate to give an overall production of 100,000 ozpa of gold from concentrate and flotation tailings. The design recovery of gold from the Albion residue was 92% but the plant frequently achieves over 95% recovery with an overall plant-wide design recovery of 86% but commonly achieving 88%.

The refurbishment project was commissioned in June 2014, with ramp-up occurring for the remainder of 2014. The plant has achieved and exceeded nameplate production, treating in fact 120,000 tpa concentrate with an overall production of 129,000 ozpa.

Further, GPM successfully achieved an overall 88% plant-wide recovery exceeding the 86% design target due to better than design performance in the Albion Process™.

Despite wild fluctuations in grade and sulphur content, GPM has kept recoveries above design using the Albion Process™.

Nordenham hits 98.8% recovery

The Albion Process™ plant at Nordenham was commissioned in March 2011. The feed to the plant is also finely ground lead/zinc concentrate from the McArthur River mine.

Nordenham has a throughput of 36,000 tpa of concentrate, and the plant produces 16,000 tpa of cathode zinc from the concentrate, at a recovery of 98.8% w/w.

The Albion Leach Reactor consists of an 800 m^3 and a 280 m^3 reactor in series. The lead residue from the Nordenham Albion Process™ plant is also sold locally to secondary lead producers.

Other sites include San Juan de Neiva, Las Lagunas and Sable.

Case studies available on request.

Scan for more information

glencoretechnology.com

Follow us

in linkedin.com/company/glencoretechnology

@GlencoreTech

facebook.com/Expertise.in.Technology

Glencore Technology

Glencore Technology develops innovative products that help mining operations extract more from their flowsheet. ISASMELT™, IsaKidd™, IsaMill™, Jameson Cell and Albion Process™ have been developed in the real world and proven in more than 500 operations across every continent.

Many of our technologies have been developed and proven at our own sites, like ISASMELT™ and IsaMill™, which were pioneered by Mount Isa Mines and helped revolutionise mining and smelting processes all over the world.

Our approach is premised on a technology partnership to provide a full product and service offering, including process flow design, engineering, equipment supply, commissioning and operational expertise, and ongoing process and maintenance support.

Glencore

Glencore is one of the world's largest global diversified natural resource companies and a major producer and marketer of more than 90 commodities. The Group's operations comprise around 150 mining and metallurgical sites, oil production assets and agricultural facilities. With a strong footprint in both established and emerging regions for natural resources, Glencore's industrial and marketing activities are supported by a global network of more than 90 offices located in over 50 countries.

Glencore's customers are industrial consumers, such as those in the automotive, steel, power generation, oil and food processing sectors. We also provide financing, logistics and other services to producers and consumers of commodities. Glencore's companies employ around 146,000 people, including contractors.

Glencore is proud to be a member of the Voluntary Principles on Security and Human Rights and the International Council on Mining and Metals. We are an active participant in the Extractive Industries Transparency Initiative.

CONTACT

Glencore Technology Pty Limited
ABN 65 118 727 870

Level 29, 180 Ann Street
Brisbane QLD 4000
Australia

T. +61 7 3833 8500
E.glencoretechnology@glencore.com.au

Chile · T. +56 2 2342 9078
Vancouver · T. +1 604 601 2070
South Africa · T. +27 11 772 0555

A GLENCORE COMPANY

D10_GLT3286ZA_07/23