JAMESON CELL
RISEING TO THE CHALLENGE

Robust, efficient, high intensity flotation technology.
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RISE THE CHALLENGE

The Jameson Cell is an efficient, low maintenance, high intensity flotation technology for new plants or low cost plant expansions.

About Jameson Cell

The Jameson Cell technology was invented in the late 1980s to overcome the design and operating inadequacies of column and conventional cells. From its first commercial installation in 1989 it has been continuously improved to make it more robust and easy to use. The latest, Mark IV Jameson Cell, combines the original advantages of small bubble size and small footprint with the new low maintenance and operator-friendly designs.

The Jameson Cell is an innovative flotation process driven by fluid mechanics. The advantages of modern Jameson Cells are:

» Consistent fine bubble generation without requiring external equipment or spargers.
» Intensive mixing with small bubbles achieving rapid flotation without mechanical agitation.
» High throughput in small tanks.
» Froth washing to maximise concentrate grade in a single flotation stage.
» Fast response and easy process control for a wide range of product grades and recoveries.

» Steady operation and performance irrespective of changes in feed flow.
» No moving parts, simple to install and maintain with excellent availability.

The Jameson Cell can treat a large amount of material in a small footprint. Cell designs are flexible to suit a number of industries, making it ideal for any new project and a great option for low cost plant expansions.

In the first 20 years of commercialisation nearly 300 Jameson Cells were installed, treating a wide range of materials including coal, base and precious metals, potash, bitumen, graphite and recovering organic in solvent extraction processes.

The Jameson Cell is also an ideal technology for non-sulfide and industrial minerals and reverse flotation of silica in iron ore processing.

Glencore Technology provides accurate cell design and scale up, engineering, manufacturing, flotation circuit design and review, installation support, cell commissioning and ongoing technical support from our experienced team of flotation, operating and engineering specialists.
Jameson Cell advantages

1. HIGH THROUGHPUT IN SMALL FOOTPRINT
Consistent generation of fine bubbles provides significantly more bubble surface area for flotation than alternative technologies. High carrying capacities allow large tonnages to be treated in a small volume.

2. HIGH CONCENTRATE GRADES
Fine air bubbles, intense mixing, high bubble loading and efficient froth washing ensures superior grade concentrates compared to mechanical cells. Liberated and fast floating particles can be recovered to a final concentrate in one step, transforming traditional flowsheet designs.

3. EASY TO TUNE – QUICK TO RESPOND
High intensity means fast kinetics and less time required to reach steady state after process changes.

4. STABLE OPERATION
The Jameson Cell quickly reaches equilibrium and can continue operating if feed supply is interrupted. Tailings recycle eliminates negative effects of fluctuating feed flow to give constant downcomer flow, consistent performance and simple startup. The cell operates at a constant feed pressure and the hydrodynamic action inside the downcomer, essential for particle collection, is always consistent.

5. MINIMAL MAINTENANCE – HIGH AVAILABILITY
No moving parts and no external air supply keeps maintenance simple and low cost. The highest wear component, the slurry lens orifices has a wear life in excess of 5 years. Downcomer maintenance can be performed while the cell is operating, in under 10 minutes.

6. EASY TO INSTALL AND COMMISSION
There are no rotors, compressors or blowers to install or operate. A feed pump is the only equipment that needs power. Commissioning is quick and simple. The cell can reach design capacity quickly after commissioning.

7. FLEXIBLE CELL DESIGNS
Cells are 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. Materials of construction are flexible and cells can be fabricated to suit the needs of the client and application.

“The simple installation and small footprint is ideal for circuit expansions.”
OPERATING PRINCIPLES

The Jameson Cell consistently produces fine bubbles and intense mixing between air and slurry. This means fast, efficient flotation.

While the principle of using air bubbles to recover particles is the basis of the technology, it is the way air bubbles are generated and how the bubbles and particles interact that make Jameson Cells unique.

In the Jameson Cell, particle-bubble contact takes place in the downcomer. The tank’s role is froth-pulp separation and may incorporate froth washing to assist in obtaining product grade.

With no agitators, blowers or compressors Jameson Cell installation is simple and operation is extremely energy efficient. Power consumption is much lower than the equivalent mechanical or column flotation cell. The energy for flotation is simply delivered by the conventional feed pump.

Optimal Jameson Cell performance is maintained by delivering a constant volumetric flowrate of pulp to each downcomer. While operating plants experience fluctuating process flows, the Jameson Cell is equipped with a tailings recycle system, that automatically compensates for feed variations. In addition to maintaining consistent and optimal downcomer operation, the tailings recycle improves metallurgical performance by giving particles multiple ‘passes’ through the downcomer contacting zone. The Jameson Cell’s ability to provide better selectivity and to control entrainment means product grade is not affected.

How much bubble surface area will 1 mm³ of flotation give you?

<table>
<thead>
<tr>
<th>Jameson Cell</th>
<th>Conventional Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Air Bubble Diameter – 0.3 mm</td>
<td>Mean Air Bubble Diameter – 1.0 mm</td>
</tr>
<tr>
<td>Total Mean Surface Area – 20 mm²</td>
<td>Total Mean Surface Area – 6 mm²</td>
</tr>
</tbody>
</table>

Stainless steel wash water system in coal flotation.
The Cell

A Jameson Cell consists of three main zones: the downcomer, the tank pulp zone, and the tank froth zone.

The **Downcomer** is the heart of the Jameson Cell where intense contact of air bubbles and particles occur. Feed is pumped into the downcomer through the slurry lens orifice, creating a high-pressure jet. The jet of liquid shears and entrains air from the atmosphere. Removal of air inside the downcomer creates a vacuum, causing a liquid column to be drawn up inside the downcomer. The jet plunges into the liquid column where the kinetic energy of impact breaks the air into fine bubbles which collide with the particles. The very high interfacial bubble area and intense mixing, results in rapid particle attachment to the air bubbles and high cell carrying capacities.

The **Tank Pulp Zone** is where mineral laden bubbles disengage from the pulp. The design velocities and operating density in this zone, keep particles in suspension without the need for mechanical agitation. Due to the rapid kinetics and separate contact zone in the downcomer, the tank is not sized for residence time, so tank volumes are much smaller than equivalent mechanical and column cells. Jameson Cells are contact dependent, not residence time dependent.

In the **Tank Froth Zone** the grade of the concentrate is controlled by froth drainage and froth washing. Cells are designed to ensure an efficient, quiescent zone that maximises froth recovery. Froth travel distance and concentrate lip loadings are integral to the tank design.

The Downcomer

The downcomer is where bubble-particle collision, attachment and collection occur. The different hydrodynamic regions of the downcomer are the Free Jet, Induction Trumpet, Plunging Jet, Mixing Zone and Pipe Flow Zone.

**Free Jet**: Slurry passing through the slurry lens orifice under pressure creates the Free Jet which shears the surrounding air and entrains it into the slurry.

**Induction Trumpet**: The Free Jet impinges on the slurry in the downcomer. The impact creates a depression on the liquid surface and results in air being channelled into the area at the base of the Free Jet.

**Plunging Jet**: High shear in the jet breaks the entrained air into a multitude of very fine bubbles (0.3 to 0.5 mm in diameter) which are carried downwards in the downcomer.

**Mixing Zone**: The Plunging Jet transfers momentum to the surrounding mixture, creating recirculating eddies of aerated liquid for intense bubble-particle collision and attachment.

**Pipe Flow Zone**: Beneath the Mixing Zone, a region of uniform multiphase flow exists. The downward liquid velocity counteracts the upward flow of mineral laden air bubbles. The air bubbles and particles pack together to form a downward moving expanded bubble-particle bed. The dense mixture of bubbles and pulp discharge at the base of the downcomer and enters the tank pulp zone where the mineral laden bubbles disengage from the pulp.
Continuous design improvements have resulted in a flotation technology with high availability, long component life and low operating costs.

**Jameson Cell engineering**

Incorporating Jameson Cell technology into your flowsheet means you do not just get a piece of equipment – you get years of flotation experience and know-how to ensure the latest generation of technology is integrated optimally in your plant.

From the initial enquiry through to project implementation, fabrication, installation, commissioning and training, our engineering team develops a flotation system that works.

Our input does not stop after commissioning and training. GT engineers provide expert technical assistance to help assess and optimise the flotation performance of your Jameson Cell.

**Specifications**

<table>
<thead>
<tr>
<th>All-in-one cells (with internal tailings recycle)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Model</td>
<td>Cell shape</td>
</tr>
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</tr>
<tr>
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<table>
<thead>
<tr>
<th>Circular cells (requiring external tailings recycle)</th>
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</thead>
<tbody>
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<td>Model</td>
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<tr>
<td>B6500/24</td>
<td>Circular</td>
</tr>
</tbody>
</table>

1 Standard cell sizes listed. Other cell sizes and shapes can be designed to meet specifications of client and project.
2 Cell sizing based on volumetric flowrate only and may vary depending on application, specific duty and flowsheet design. Carrying capacity and lip loading considerations may alter cell sizing.
High throughput capacity in a small footprint providing a simple and flexible installation.

Jameson Cell maintenance

The maintenance benefits of the Jameson Cell technology are:

» No moving parts.
» Safe to maintain.
» Easy access to serviceable components.
» Wear parts can be changed on the run.
» No special tools required for routine inspection and maintenance procedures.
» No lubricants required.
» Slurry lens orifice has a long service life (+3 to +5 years) under normal operating conditions.
» Long service life for other wet end wear parts under normal operating conditions.

Jameson Cell maintenance is minimal and relies on monitoring process conditions and conducting periodic inspection. Inspections are quick and can be completed without tools and during cell operation.

Layout and control systems

Jameson Cells come complete with all necessary valves, instrumentation and control philosophy for simple integration into your control system.

All critical process parameters required for optimising flotation performance are automated, monitored and controlled.

Internal Recycle Control

Internal Recycle Control with integral cell, pump and tailings recycle boxes for installation on one level.

External Recycle Control

External Recycle Control allows for maximum flexibility in plant layout utilising gravity flow of products to the next stage.
Accurate Design

Direct scale up from laboratory and pilot scale testwork is proven. Using Jameson Cell technology in your flowsheet significantly reduces project risk.

Accurate testwork and scale up is essential for optimal plant performance. The hydrodynamic conditions for particle collection inside the downcomer and separation in the tank are identical between laboratory, pilot plant and full scale Jameson Cells. Scale up is direct and proven.

GT has the operational experience and expertise to supply Jameson Cells to meet project design criteria and ensure effortless flowsheet integration. Using pilot or laboratory scale test units, we can design a testwork program to suit your needs. If Jameson Cell testwork is not practical we can use our extensive body of knowledge, testwork and full scale data to recommend a system suitable for you. In many cases, standard laboratory based testwork, using mechanical cells, can be used for Jameson Cell sizing.

Testwork Options

GT can recommend and organise batch laboratory tests using a L150/1 laboratory unit or continuous onsite testwork using an L500/1 pilot plant test rig. All Jameson Cell test rigs come complete with auxiliary equipment including downcomer assembly, pump box with tailings recycle arrangement, feed pump, wash water system, control panel, valves and instrumentation.

Continuous onsite pilot plant testing produces the most reliable results for design and simulates full scale operation.

The benefits of onsite testwork include:

- Ability to test a representative stream from the existing plant and to assess flotation performance with variations in plant feed.
- Ability to investigate and understand the effect of process variables on flotation performance. Process parameters can be deliberately manipulated to assess performance over the entire grade-recovery range.
- Flexibility to perform as many tests as desired to ‘prove up’ design.

Scale Up

In conventional or column flotation, scale up factors are required when using laboratory or pilot plant results for full scale design. These factors account for variations in cell geometry, mixing patterns (short circuiting) and energy intensity between the different sized units. The scale up factors can also change depending upon the duty, feed characteristics and flotation kinetics.

No scale up factors are required for the Jameson Cell design. This is because the jet velocity, air entrainment and hydrodynamic conditions for mixing are identical across different sized cells from laboratory to full scale. The operating principle and parameters of the downcomer are exactly the same irrespective of cell size. For large cell sizes simply more downcomers are used. Direct scale up has been proven across different applications including coal, base and precious metals, solvent extraction and industrial minerals.
20 years of development

The first Jameson Cells were a big improvement on columns but they still needed to be more robust to better suit operating conditions.

GT’s operators and engineers have worked with Jameson Cell users for 20 years to continuously improve the robustness and reliability of the Jameson Cell.

Two decades of significant advances have culminated in the latest model, the Mark IV Cell. The Mark IV Jameson Cell incorporates:

- Feed recycle systems to ensure stable cell and downcomer operation and optimum performance independent of feed fluctuations. The cell operates consistently even when feed stops.
- Low wear, high discharge coefficient slurry lens orifice.
- Flexible feed nozzle allows quick and easy inspection and perfect alignment of the plunging jet to maximise metallurgical performance.
- Upgraded above-froth or in-froth wash water system.

Technology partnership concept

The Jameson Cell has been continuously developed and improved from experiences at client’s and Glencore’s own operating sites. The result is more than just flotation equipment, it is years of experience and know-how that is incorporated into our design and recommendations.

Our Technology Partnership concept is the vehicle that makes this body of knowledge and experience available to you, enabling your company to achieve the full potential benefits of the Jameson Cell Technology:

- GT has an ongoing technical relationship with users.
- We facilitate interchange of learning’s between users.
- Glencore has been using Jameson Cell technology as a core part of its’ own processing operations since the 1980s.
- Our extensive operating experience combined with the latest equipment and process development produces a package that delivers rapid technology transfer to your operation.

Glencore Technology

GT develops, markets and supports technologies for the global mining, coal, mineral processing, industrial minerals, oil sands and metals extraction industries. It has offices in Australia, South Africa, Europe, Canada, Russia, China and Chile, and is a wholly owned subsidiary of Glencore, a major global diversified mining group.

For further information please visit www.glencoretechnology.com.
Jameson Cells in Coal Flotation

In a Coal Handling and Preparation Plants (CHPP), gravity separation techniques are used to separate coal from ash. At fine particle sizes (below 500 μm) gravity separation is inefficient and flotation is required. Early coal operations used conventional flotation technology however high throughputs and strict product ash requirements made the circuits complex and inefficient with inconsistent performance.

The Australian Coal Industry served as a rigorous testing ground for the Jameson Cell in the 1980s culminating in the first full scale Jameson Cell coal installation at Newlands in 1990. The Jameson Cell is now the industry standard with over 100 coal cells installed by 2010 in Australia alone. The fine bubble size, high intensity and froth washing ability offer major advantages over conventional cells for recovery of the highly hydrophobic, fast floating coal fines. These advantages provide superior, more consistent flotation performance, lower ash concentrates and high recovery. Coupled with high throughputs, small footprint, simple installation and high availability the Jameson Cell has set the standard for installations in the coal industry. The largest installation at Curragh (Australia) treats over 5 Mtpa of coal fines using only twelve cells. Jameson Cells are also installed in coal operations in Africa, North America, Asia and Europe and their simple integration into modular plants has meant the advantage of Jameson Cells are now extended to the recovery of coal fines in tailings dams.

The integration of Jameson Cell technology into a flowsheet produces a robust and efficient plant requiring less cells, equipment and space. Consistent fine bubble generation, high intensity mixing and froth washing allow Jameson Cells to recover minerals quickly and at superior concentrate grades compared to mechanical cells. The Jameson Cell’s ability to treat large throughputs in a small footprint makes them perfect for inclusion into retrofit and expansion projects.

The Jameson Cell is particularly suited for:

» Removal of naturally hydrophobic gangue (carbon and talc) at the head of the flotation circuit where Jameson Cells act as roughers or rougher cleaners minimising entrainment of the valuable minerals to the ‘throw away’ concentrate that mechanical cells simply cannot match.

» Pre-roughing (rougther scalper) and roughing duties where selectivity and froth washing produce a high grade concentrate. The recovery in one Jameson Cell is usually equivalent to several mechanical cells. When the feed contains liberated, fast floating mineral particles, the Jameson Cell produces final grade product reducing the number of cells required for downstream processing.

» Pre-cleaning (cleaner scalper) duties where the Jameson Cell recovers the fast floating minerals producing a final grade concentrate. In this duty the Jameson Cell takes the load off downstream processing reducing the required size of the conventional cleaning circuit. A pre-cleaning Jameson Cell offers a quick, simple and cost effective solution for plants needing additional cleaner capacity.

» When mechanical cleaning circuits are unable to consistently produce final grade concentrates due to entrained gangue, the Jameson Cell with its superior selectivity and froth washing can produce the required final concentrate grade.

Jameson Cells are installed in copper, gold, copper-gold, lead-zinc-silver, nickel and platinum operations throughout the world.

Jameson Cells in Base and Precious Metals Flotation

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Jameson Cells in Oil Sands

Following years of development and testing in oil sands flotation the first full scale Jameson Cell downcomers were installed into oil sands processing in 2009. The fine bubbles and intense mixing results in efficient bubble-particle contact producing high grade bitumen froth at high recoveries in a single stage. Superior process performance, no moving parts and higher availability are fundamental to the selection of Jameson Cells over alternative technologies for retrofits, expansions and new projects. High capacity Jameson Cells with large scale downcomers accommodate the large tonnages mined and treated in this industry.

Jameson Cells in Industrial Minerals

Jameson Cell technology was introduced into the industrial minerals industry in 1993 to recover potash ‘slimes’. In a cleaning duty, a single stage Jameson Cell can replace banks of mechanical cells and achieve final grade at maximum recovery. A retrofit installation reported energy savings of up to 76% when replacing 16 mechanical cells with one Jameson Cell. Savings are also achieved in reduced circuit footprint, wear parts and maintenance.

Flotation of semi-soluble salt minerals, such as phosphate, fluorite and calcite, are controlled by surface chemistry where selection of appropriate reagents and conditioning methods drive recovery. Once hydrophobic, the minerals are fast floating making conditions in the Jameson Cell perfect for recovering these minerals. In these applications, Jameson Cells have been designed for roughing, scavenging and cleaning duties.

Installations

From the installation of the first Jameson Cell at Mount Isa in 1989, Jameson Cells are now operating in major plants around the globe.

For a current installation list please visit our website www.jamesoncell.com
Glencore operates mines throughout the world. Tough testing grounds that make our process technologies the best on earth.