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Improved Copper Recovery and Selectivity with NovaCell™ CPF Technology

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ABSTRACT

An existing copper operation in Australia is evaluating the viability of coarse particle flotation (CPF) technologies to treat material from the cyclone underflow and rougher tailings streams. As part of this assessment, plant samples were tested using the NovaCell™ flotation system.

NovaCell™, developed by Laureate Professor Graeme Jameson and supplied commercially by Jord International, is a novel flotation device that integrates high-shear downcomers, a low-shear fluidised bed, and an internal separation cone. This configuration enables high recovery efficiencies for both coarse and fine valuable particles within a single integrated unit.

On the cyclone underflow stream, NovaCell™ achieved a copper recovery of 88% at a 15% mass pull. When benchmarked against a competitor hybrid CPF circuit, which requires de-sliming and separate flotation stages for fines and coarse particles, NovaCell™ delivered comparable recovery without the additional processing steps. This integrated approach offers potential for simpler circuit design, reduced processing complexity, and lower capital and operating costs.

In the rougher tailings stream (after de-sliming), NovaCell™ achieved a copper recovery of 66% at a 6% mass pull. While the competitor circuit delivered similar recovery, it did so at a significantly higher mass pull of 25%, highlighting significant improvement in selectivity for NovaCell™. This has direct implications for reducing the regrind load and downstream cleaner processing, further enhancing operational efficiency and product quality.

This article presents the test program outcomes and explores the potential role of NovaCell™ in future CPF circuit design for copper operations.

INTRODUCTION

As ore grades decline, coarse particle flotation (CPF) is becoming increasingly important for improving resource efficiency in the mining industry. Conventional flotation systems (i.e. mechanically agitated tank cells) struggle to recover particles larger than 150 μm, leading to significant metal losses. CPF offers potential benefits such as reduced grinding energy, lowering water consumption, and improved tailings management. However, its adoption has been limited by technical challenges in achieving both high recovery and selectivity. New technologies like NovaCell are now addressing these limitations, offering copper operations a practical path to recover coarse material once considered unrecoverable.

NovaCell™ is a novel fluidised bed flotation device designed to efficiently recover both fine and coarse particles within a single, integrated system. It addresses the fundamental challenge of differing hydrodynamic requirements for fine and coarse particle flotation. Fine particles require high-shear environments to overcome the water film surrounding air bubbles and attach effectively. Once attached, their low mass makes them less prone to detachment. In contrast, coarse particles can attach more readily in low-shear conditions, but their higher mass and momentum increase the risk of detachment under turbulent conditions. This trade-off limits the performance of conventional flotation cells.

NovaCell™ overcomes this limitation by incorporating two distinct collection zones. The feed is first introduced into a high-shear downcomer, where it is mixed with air and passed through a nozzle to promote high-intensity mixing ideal for fine particle capture. The aerated slurry then enters a fluidised bed of coarse particles at the base of a flotation column, where coarse particles interact with bubbles in a low-shear, quiescent environment. Once attached, particles of all sizes rise with the bubble stream into the froth layer. Any coarse particles that may struggle to remain in the froth and drop back, are recovered through an internal cone that feeds a screen, enhancing the overall recovery of coarse particles and reducing losses.

Figure *1* presents two images. On the left is the NovaCell™ demonstration plant and on the right is the NovaCell™ small-scale rig that was used for this test work.

Figure 1 NovaCell™ demonstration plant (left) and NovaCell™ small-scale test (right)

RESULTS

Cyclone Underflow Stream

The cyclone underflow sample indicated a grind size (P80) of ~240 μm and was screened at 600 μm. The +600 μm fraction accounted for approximately 6% of the total mass and 6% of the copper distribution. The -600 μm material was processed in the NovaCell™ and the copper recovery size by size is presented in Table 1.

The NovaCell™ CPF achieved an overall copper recovery of 88% at a 15% mass pull. In the coarsest size fractions (-600+425 μm, -425+300 μm) copper recoveries were 26% and 66%, respectively. For the remaining size fractions, which contained majority of the copper, recoveries were 90% or higher.

Table 1 Cyclone Underflow, NovaCell™ results

Particle Size (μm)	Feed Distribution		NovaCell Recovery		Tails	
	Mass	Copper	Mass	Copper	Mass	Copper
-600+425	4%	3%	3%	26%	97%	74%
-425+300	7%	6%	12%	66%	88%	34%
-300+212	11%	9%	35%	90%	65%	10%
-212+106	35%	32%	16%	90%	84%	10%
-106+53	32%	27%	8%	92%	92%	8%
-53	11%	25%	15%	92%	85%	8%
Total	100%	100%	15%	88%	85%	12%

The NovaCell™ CPF results were benchmarked against a competitor hybrid CPF circuit in Figure 2 and Figure 3. In both cases, tests were conducted on small-scale equipment and the client provided the reagent type and dosages rates. Notably, the competitor testwork was conducted on-site using fresh material, whereas the NovaCell testwork was performed on samples that were collected on-site and subsequently transported to a laboratory for testing.

The competitor CPF equipment only treats the coarse fraction (+53 μm), requiring an upfront de-sliming stage in which the fines (–53 μm) are processed separately in a conventional flotation circuit. In this configuration, the competitor CPF achieved 85% copper recovery at a 20% mass pull, while the conventional flotation recovered 92% of the copper at a 10% mass pull. The combined copper recovery was comparable to that of the NovaCell™ CPF, which achieved this performance without the need for de-sliming or separate fine and coarse flotation stages. The NovaCell™'s CPF integrated approach offers a significant opportunity to simplify circuit design, reduce processing complexity, and lower both capital and operating costs for mineral concentrators.

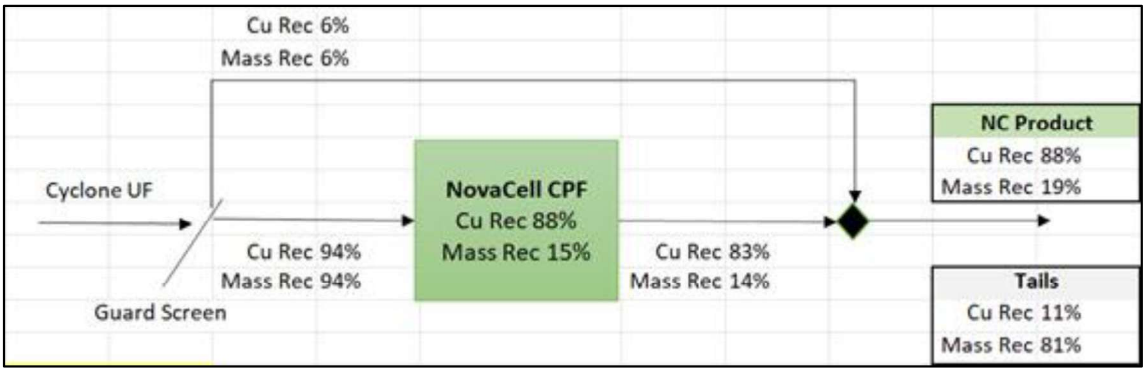

Figure 2 Cyclone Underflow, NovaCell™ CPF results

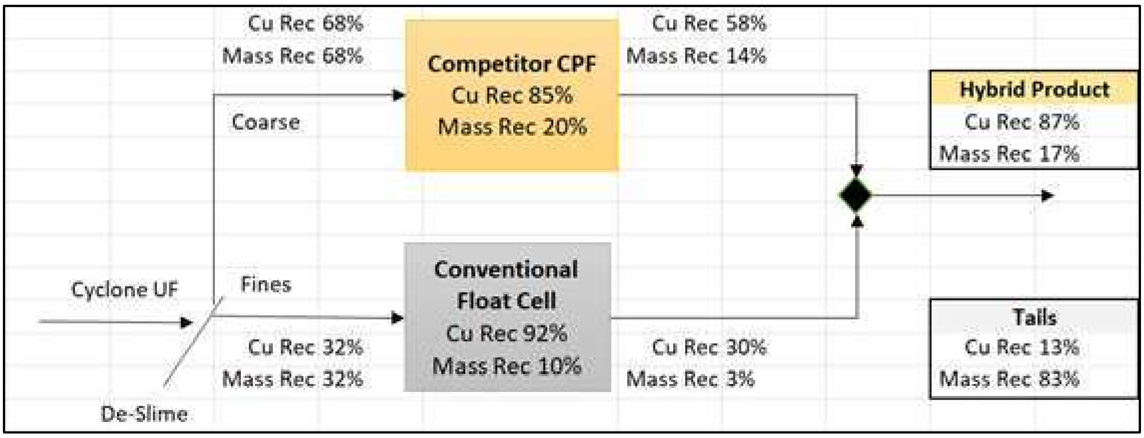

Figure 3 Cyclone Underflow, Competitor CPF results

Rougher Tails (De-slimed) Stream

The rougher tails sample, after de-sliming at 53 µm, indicated a grind size (P80) of ~175 µm and was processed directly in the NovaCell™. The copper recovery size by size results is presented in Table 2. The NovaCell™ CPF achieved an overall copper recovery of 66% at a 6% mass pull. All size fractions indicated copper recoveries above 50%, with the -300+212 µm size fraction achieving the highest copper recovery at 85%.

Table 2 Rougher Tails, NovaCell™ results

Particle Size (µm)	Feed Distribution		NovaCell Recovery		Tails	
	Mass	Copper	Mass	Copper	Mass	Copper
-600+300	1%	1%	6%	53%	94%	47%
-300+212	7%	6%	10%	85%	90%	15%
-212+106	37%	34%	6%	69%	94%	31%
-106+53	41%	39%	6%	67%	94%	33%
-53	14%	20%	3%	57%	97%	43%
Total	100%	100%	6%	66%	94%	34%

As with the cyclone underflow test, NovaCell™ CPF performance was benchmarked against a competitor CPF circuit in Figure 4 and Figure 5. All tests were conducted using small-scale equipment, applying client-specified reagent types and dosage rates. Likewise, the competitor testwork was performed using fresh plant material and the NovaCell testwork was performed using collected samples delivered to the laboratory.

The competitor CPF achieved 65% copper recovery at a 25% mass pull, demonstrating copper recovery comparable to the NovaCell™ CPF but at approximately four times the mass pull. These results show that the NovaCell™ CPF delivers an improvement in selectivity by a factor of ~4, reducing the volume of material requiring downstream processing through regrind and cleaner stages. The outcome presents a substantial opportunity to reduce both capital and operating costs, while also improving the likelihood of producing higher-quality, saleable concentrates.

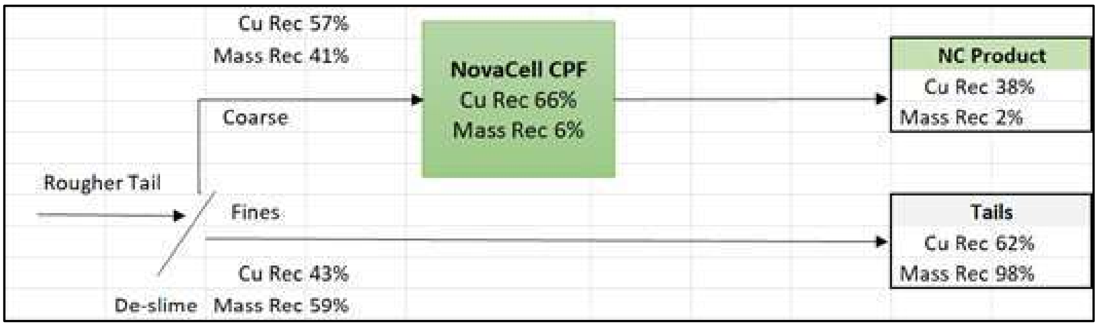

Figure 4 Rougher Tails, NovaCell™ CPF results

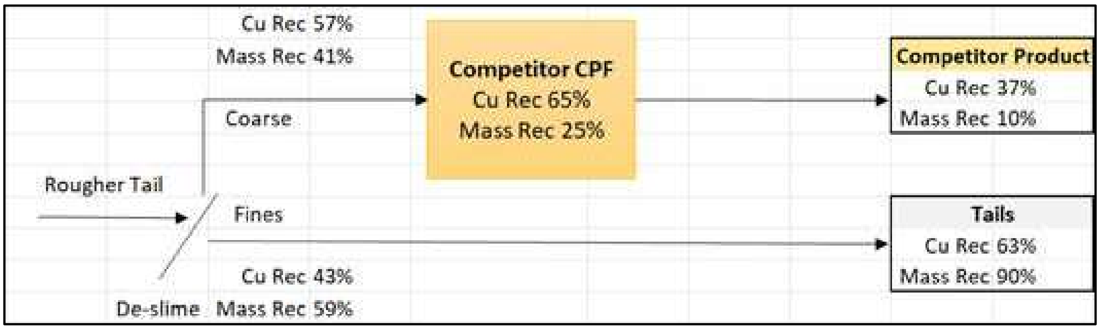

Figure 5 Rougher Tails, Competitor CPF results

CONCLUSIONS AND RECOMMENDATIONS

The NovaCell™ demonstrated strong performance on both the cyclone underflow and rougher tails streams, achieving high copper recoveries across a wide particle size range without the need for separate fine and coarse flotation stages. On the cyclone underflow stream, NovaCell™ achieved 88% copper recovery at a 15% mass pull, with >90% recovery in the size fractions containing most of the copper. On the de-slimed rougher tails, copper recovery was 66% at 6% mass pull, with notably high selectivity (~4× improvement over the benchmark circuit).

These results highlight NovaCell™'s ability to simplify flotation circuit design by integrating fine and coarse particle recovery in a single device. In both streams tested, NovaCell™ matched or exceeded the performance of competitor CPF circuits, while offering significantly lower mass pulls and reduced circuit complexity. This translates to potential reductions in capital cost, power consumption, and downstream processing loads, as well as improved concentrate quality.

Based on these findings, it is recommended that operations considering coarse particle flotation evaluate NovaCell™ as a viable alternative to hybrid CPF circuits. Pilot-scale trials on-site would provide further validation under continuous plant conditions and help define integration opportunities into existing or new flowsheets.