Coarse Particle Flotation without Desliming: Performance of NovaCell CPF Technology

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ABSTRACT

Coarse particle flotation (CPF) circuits are increasingly being implemented in concentrators, particularly in tailings scavenging applications, to improve overall metal recovery and reduce losses of liberated valuable coarse particles. However, conventional CPF technologies are constrained by their limited selectivity when treating fine particles, with fines typically reporting to the concentrate and diluting product grade. To mitigate this, most CPF circuits incorporate an upfront classification stage to remove fine material, which can then be processed separately using flotation technology better suited to selective fines recovery. While effective, this approach introduces circuit complexity, increasing capital intensity and operating costs.

The patented NovaCell CPF technology offers a simplified alternative by treating both coarse and fine particles within a single flotation device, without compromising recovery or selectivity. By integrating high-shear downcomers, a fluidised bed environment, and an internal separation mechanism, this flotation cell achieves highly efficient and selective recovery across a broad particle size distribution.

This paper presents results from the Mantos Blancos pilot plant campaign, highlighting the copper enrichment ratios achieved when processing bulk tails (the full particle size distribution) compared to fine (-45 μm) and coarse (–500+300 μm) material. The results demonstrate that NovaCell maintains strong selectivity across all size fractions, eliminating the need for desliming and separate fines flotation circuits.

Laboratory-scale testwork across multiple copper plant tailings samples is also presented confirming the reproducibility of these outcomes, delivering high enrichment ratios for bulk tailings at both fine and coarse particle sizes. The results highlight the potential of this novel flotation cell to simplify the design of coarse particle flotation (CPF) circuits and to target reductions in capital intensity and operating costs.

INTRODUCTION

Some mines have adopted CPF circuits into their flowsheets in recent years. The first large-scale sulphide CPF installation was commissioned for a tailing scavenging application at Cadia Valley Mine, Australia, owned by Newmont. Since then, similar circuits have been installed at Quellaveco Mine, Peru (owned by Anglo American) and Carrapateena Mine, Australia (owned by BHP).

For this type of technology, optimal performance is achieved when the fine fraction in the feed is removed or minimized prior to treatment in HydroFloat™, due to the impact that fines have on the fluidization water (Concha et al., 2023). As a result, and as shown in Figure 1, all the installations mentioned include an upfront classification stage and require a separate flotation circuit to recover valuable minerals from the previously classified fine material.

More recently, other CPF technologies being commercialised have suggested similar challenges. Kupka et al. (2025) showed that after laboratory testing across a range of copper ores, the fine particles preferentially reported to the product via entrainment, resulting in reduced selectivity.

The NovaCell CPF technology, developed by Professor Graeme Jameson and supplied commercially by Jord International, is designed to achieve high recovery efficiencies and selectivity for both coarse and fine valuable particles within a single integrated unit. Thus, there is no need for a deslime circuit or separate fines flotation circuit, refer to Figure 2 which shows a simplified CPF flowsheet, targeting reduced capital intensity and lower operating costs.

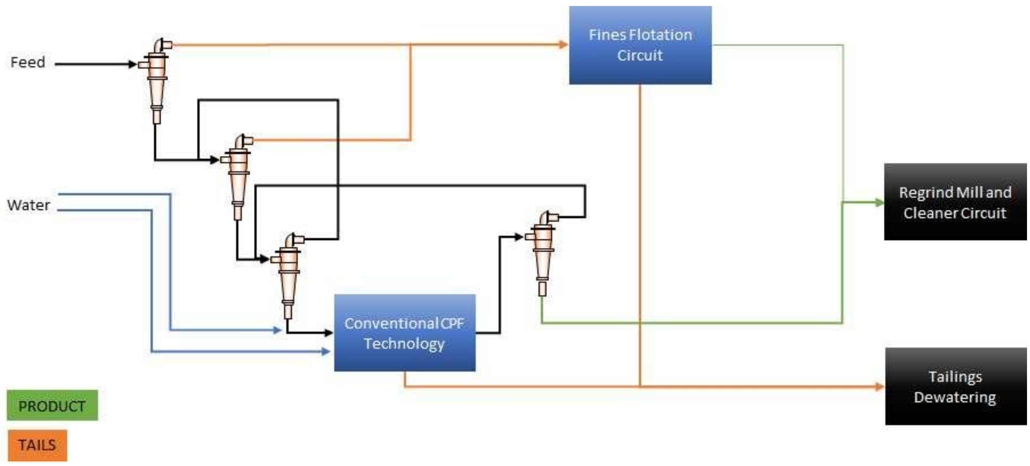

Figure 1 Process schematic of conventional CPF circuits with desliming and separate fines flotation circuit

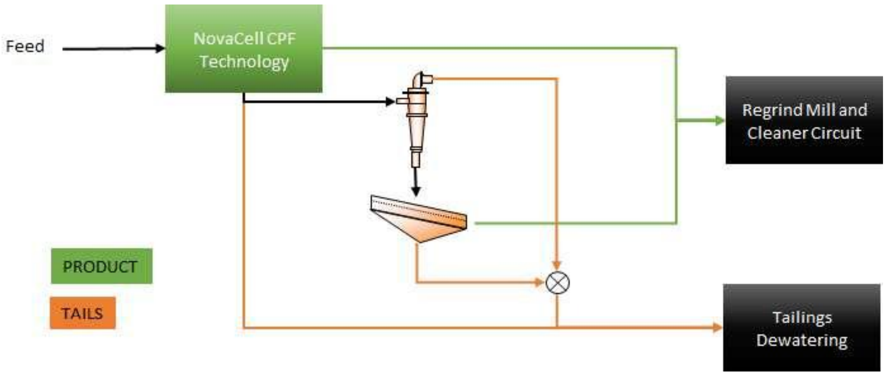

Figure 2 Process schematic of NovaCell™ CPF circuit without desliming or separate fines circuit

RESULTS

Mantos Blancos Pilot Plant Trial

The Mantos Blancos mine is a copper-silver deposit located in the northern region of Chile and is owned by Capstone Copper (Capstone). Capstone wanted to investigate NovaCell in a tailings scavenging application and provided plant tailings samples for laboratory testing. The promising results lead to an onsite continuous flotation pilot plant trial for a six-month period. Flores et al. (2025) reported that laboratory performance translated effectively to pilot-scale operation. The trial achieved up to 56% copper recovery and consistently exceeded expected targets for copper enrichment ratio (6.1) and product mass pull (8%).

During the validation phase of the trial was run over 8 days, during which 16 tests samples were collected, screened and evaluated on a size-by-size basis. The NovaCell copper recovery for bulk tailings, the –45 µm (fine) fraction, and the –500+300 µm (coarse) fraction, as a function of product mass pull is presented in Figure 3. Bulk recovery represents the full particle size distribution.

The results indicate that copper recovery for all size fractions plots well above the selectivity line, demonstrating strong metallurgical performance across all size fractions. Importantly, the fine fraction (–45 µm) exhibits a significant enrichment ratio, whereas in conventional CPF technologies there is no enrichment and all fine recovery is due to entrainment. The results for the coarse fraction confirm that the selectivity of this flotation cell is achieved without compromising coarse particle recovery.

The NovaCell average copper enrichment ratios for bulk recovery, –45 µm, and –500+300 µm fractions are 6.1, 4.1, and 5.3, respectively (refer to Figure 4). While the fine fraction exhibits the lowest enrichment ratio, it remains significantly greater than 1.0. For comparison, in conventional flotation systems, enrichment ratios approaching 1.0 are typically indicative of entrainment-dominated recovery.

In summary, the pilot plant results demonstrate that fine particle recovery in this technology is predominantly driven by selective flotation rather than entrainment, while simultaneously maintaining strong coarse particle performance. This combination highlights NovaCell's unique ability to treat the full particle size distribution without the need for desliming or separate fines flotation circuits. It is also important to note that this level of selectivity in fines particles is achieved without the use of wash water injection, which will be implemented in future NovaCell operations and is expected to further improve selectivity. To assess whether this behaviour is consistent across other ore types, laboratory results from various plant tailings samples were evaluated using the same methodology.

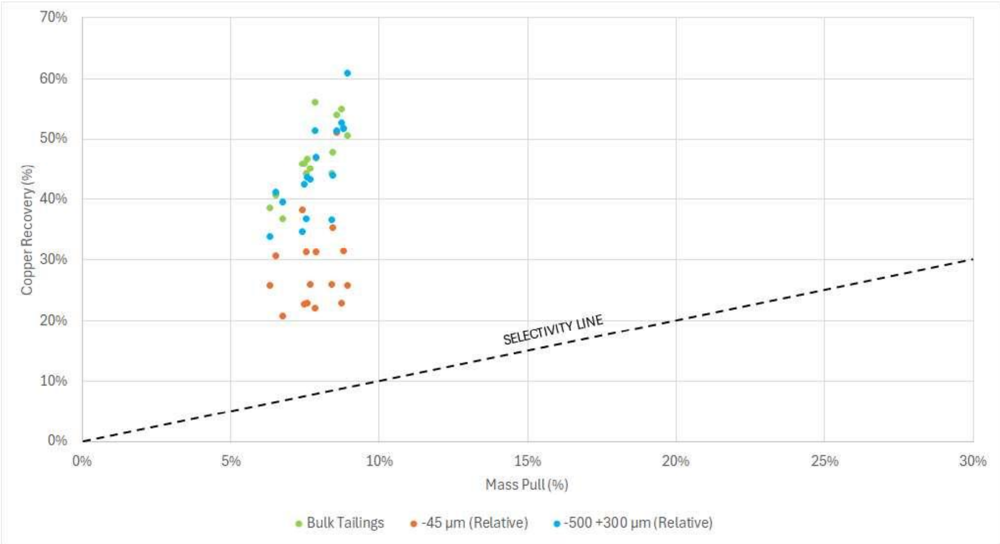

Figure 3 Pilot NovaCell™ copper recovery for bulk tailings, – 45 μm & – 500+300 μm vs mass pull

Figure 4 Pilot NovaCell™ copper enrichment ratio for bulk tailings, – 45 μm & – 500+300 μm material

Laboratory Testwork on Plant Tailings Samples

The NovaCell laboratory unit was used to investigate the metallurgical performance of three (3) plant tailings samples (labelled Case studies 1 to 3) taken from different copper concentrators. Table 1 details the site location, and the Cu grade (%) and P80 size of the tailings material. In all three case studies, the results were analysed on a size-by-size basis.

Table 1 Plant tailings samples tested with NovaCell™ under laboratory conditions

Case Studies	Site Location	Plant Tails Grade (% Cu)	Plant Tails Size (P_{80})
1	USA	0.06%	231 µm
2	USA	0.03%	212 µm
3	Chile	0.16%	200 µm

The NovaCell copper recovery for bulk recovery, the –53 µm (fine) fraction, and the –425+300 µm (coarse) fraction, as a function of product mass pull is presented in Figure 5. Like with the pilot plant results, the fine fraction (–53 µm) reports well above the selectivity line without compromising coarse particle recovery.

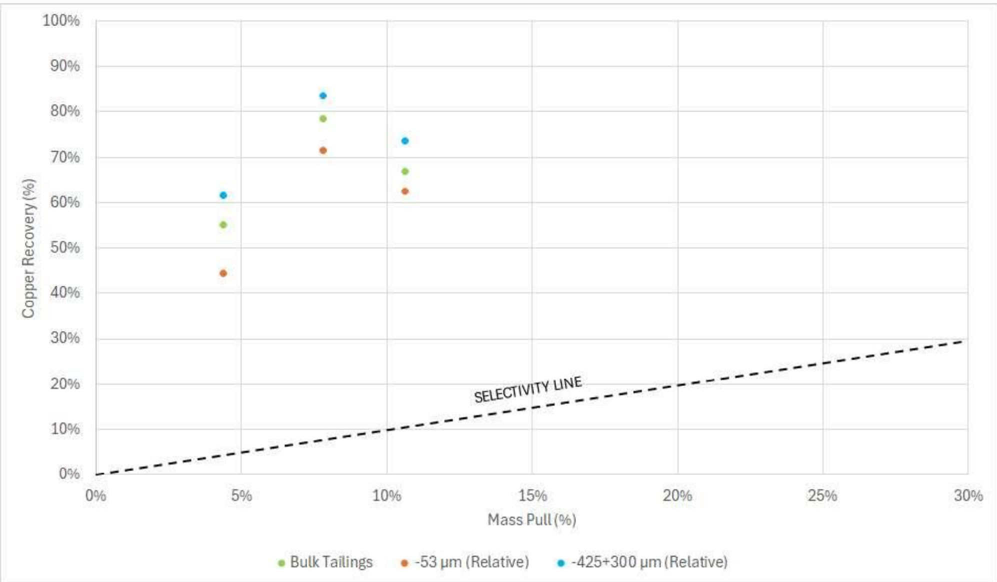

Figure 5 Laboratory NovaCell™ copper recovery for bulk tailings, – 53 µm & – 425+300 µm vs mass pull

The NovaCell average copper enrichment ratios for bulk recovery, –53 µm, and –425+300 µm fractions are 9.6, 6.6, and 8.6, respectively (refer to Figure 6). These results confirm that across multiple plant tailings samples, fine fraction copper enrichment ratios well above 1.0 can be achieved.

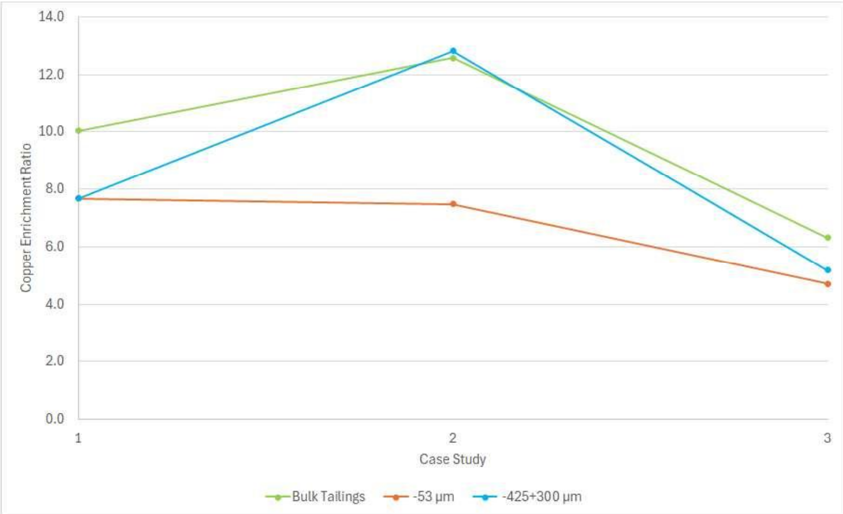

Figure 6 Laboratory NovaCell™ copper enrichment ratio for bulk tailings, – 53 µm & – 425+300 µm

CONCLUSIONS

The results presented at pilot and laboratory scale demonstrate that the NovaCell CPF technology can selectively recover both coarse and fine valuable minerals in a single device.

The Mantos Blancos pilot plant size-by-size analysis showed that both coarse and fine fractions exhibit a high degree of selectivity, indicating true flotation rather than entrainment-driven recovery. Importantly, the fine fraction consistently achieved copper enrichment ratios well above 1.0, a result not typically observed in conventional CPF systems.

Supporting laboratory testwork across multiple plant tailings samples confirmed these findings, with high enrichment ratios achieved across the entire particle size range. The reproducibility of these results across different ore types confirms that the selective recovery of fine particles in this technology is not ore-specific and is robust.

Overall, the results demonstrate that this new flotation cell offers a compelling alternative to conventional CPF circuits. The ability to treat the bulk feed without desliming simplifies overall operability and decreases circuit complexity, with potential savings in capital intensity and operating costs. In addition, the improved selectivity of NovaCell across all size fractions reduces the burden on downstream regrind and cleaning circuits.

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