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FLOTATION DIVISION

World Leader in Advanced
Flotation Technology

StackCell®: A new mechanical cell for high rate flotation

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ERIEZ *A Subsidiary of Eriez Manufacturing Company | Erie, PA, USA*

Presentation outline

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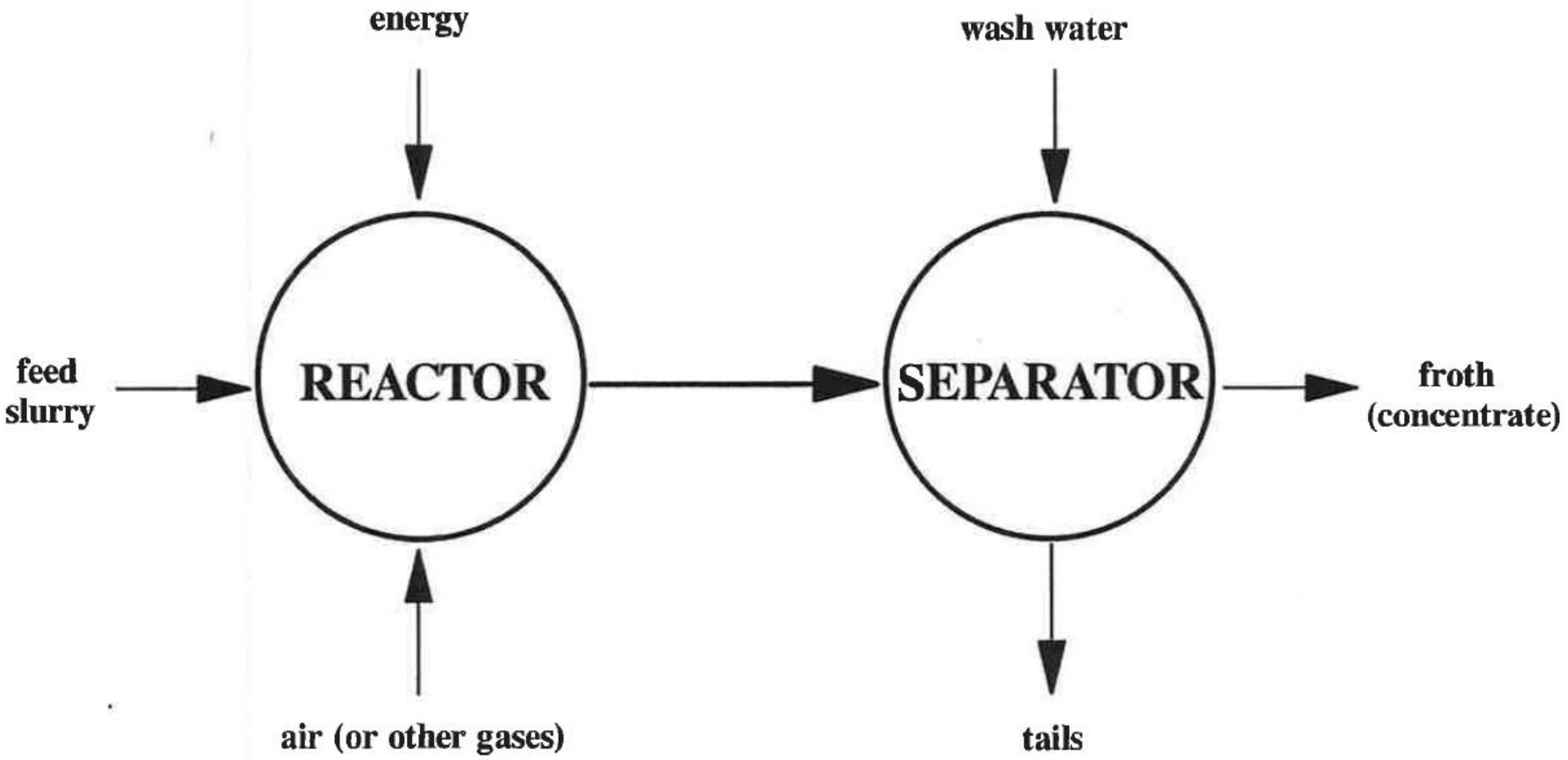
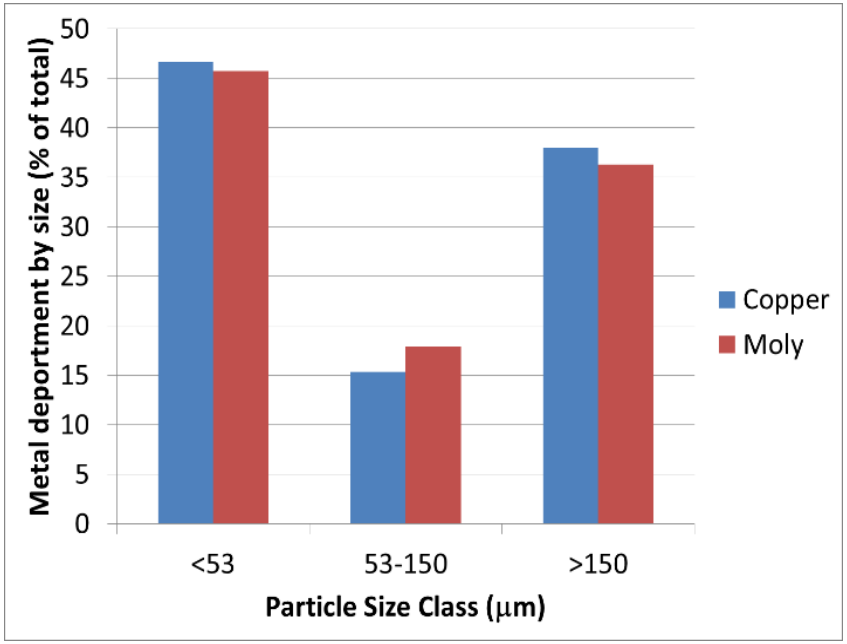
- The two stage flotation paradigm
- The Eriez implementation: StackCell™
- Results from industrial benchmarking (a) copper roughing and (b) nickel cleaning
- Implications for CAPEX and OPEX
- Conclusions

Two stage flotation concept*

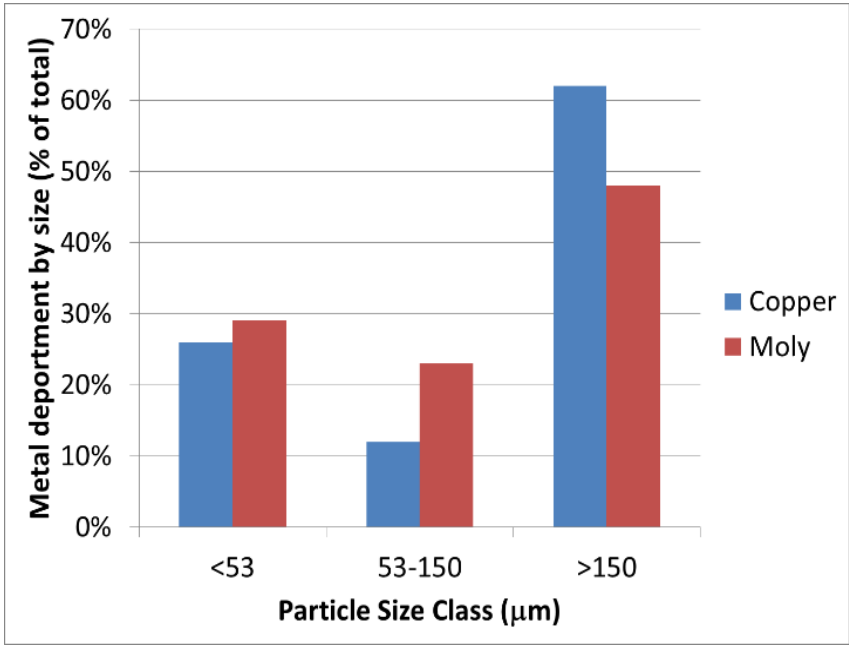


*Zhou, Zhi-ang, (1996). “Gas nucleation and cavitation in flotation”, PhD Thesis, McGill University

A measure of the weakness of conventional mechanical cells



Tails of Producer A



Tails of Producer B

Metal deportment of final tailing by size for two copper/moly plants in the Americas, each >100,000 tpd operations

Eriez StackCell ™

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- Based on the two stage concept
- Used commercially for coal roughing since 2007 (more than 20 units sold), up to 3.7 metre diameter scale
- Patented in key jurisdictions throughout the world (US application April 2008, awarded Feb 2015)
- Now focusing on sulfide applications

Eriez StackCell ™: How it works

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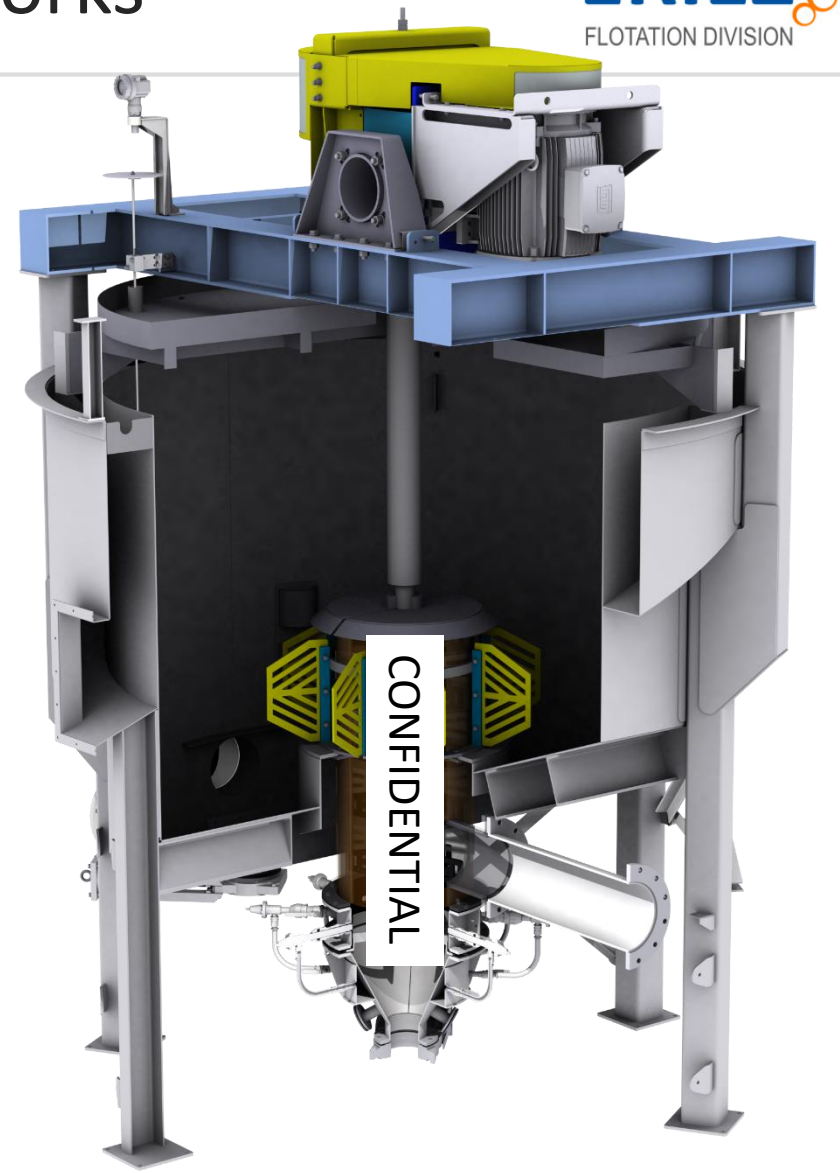
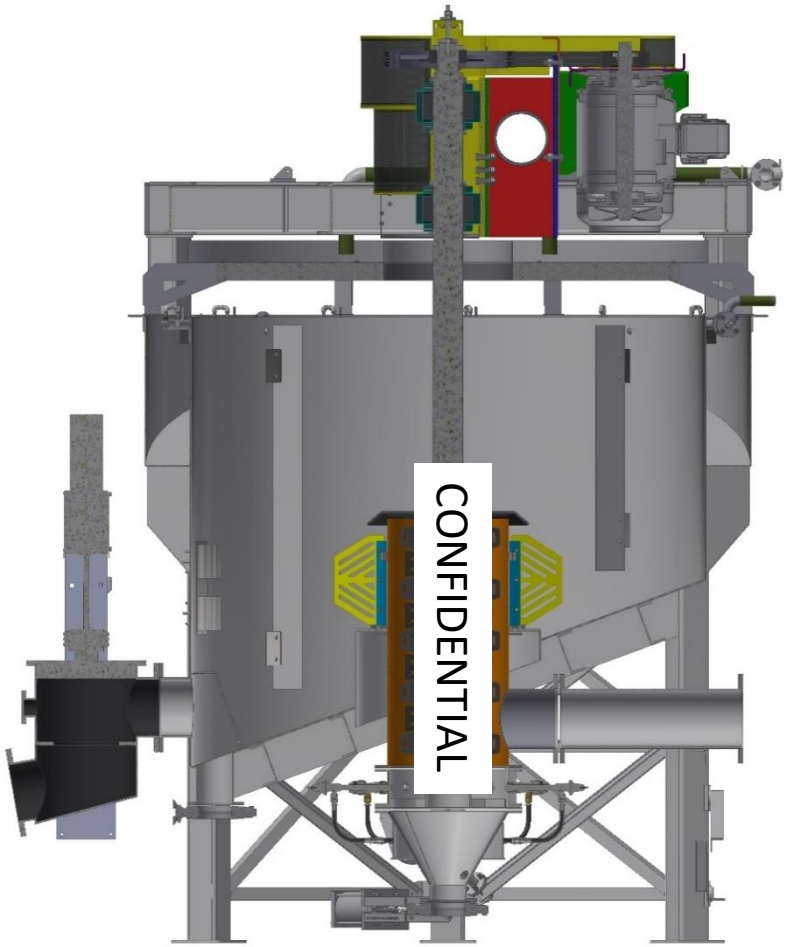
- Tank inside a tank with 1-way isolation of fluid between tanks
- Internal tank has high energy dissipation for collection, external tank has low energy quiescent conditions for froth recovery



Eriez StackCell ™: The inner tank

- Air and feed pulp are fed into the inner tank
- Internal tank is bounded by a cylindrical wall and a top rotating “lid” separated by a thin annular gap
- Rotors & stators on a single shaft for high energy transfer
- Aerated pulp is conveyed through the gap under pressure and cannot re-enter the internal tank



Benchmarking with a Cu rougher application

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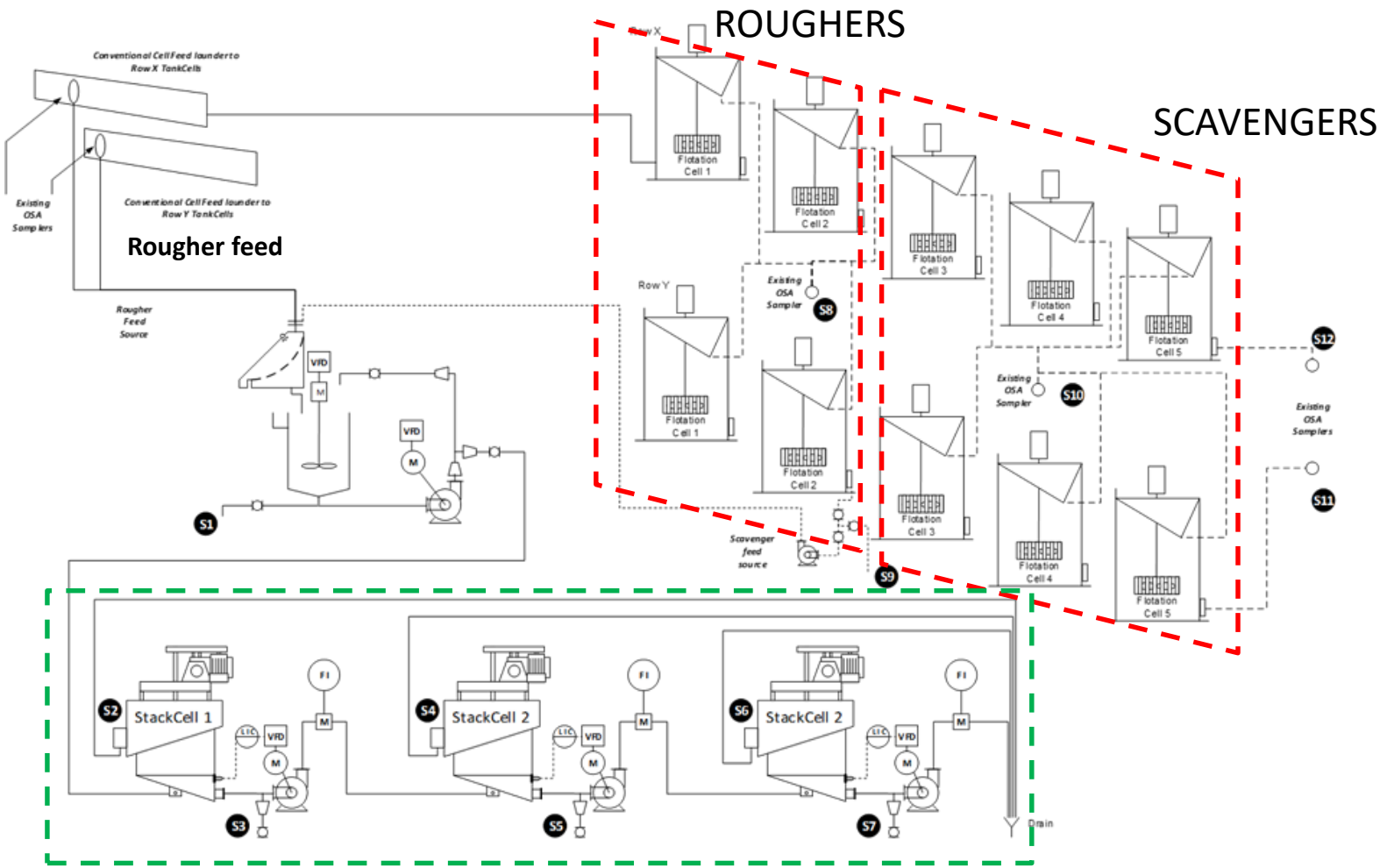
- Side by side evaluation on fresh production copper porphyry ore slurry

1. Production configuration = 2x R(2)-Sc(3)
2. Compared train of 3x StackCells (0.61 metre diameter)
3. Denver batch tests (Denver batch test on feed available from a local commercial lab)

Block diagram of Cu rougher comparison



Train of StackCells

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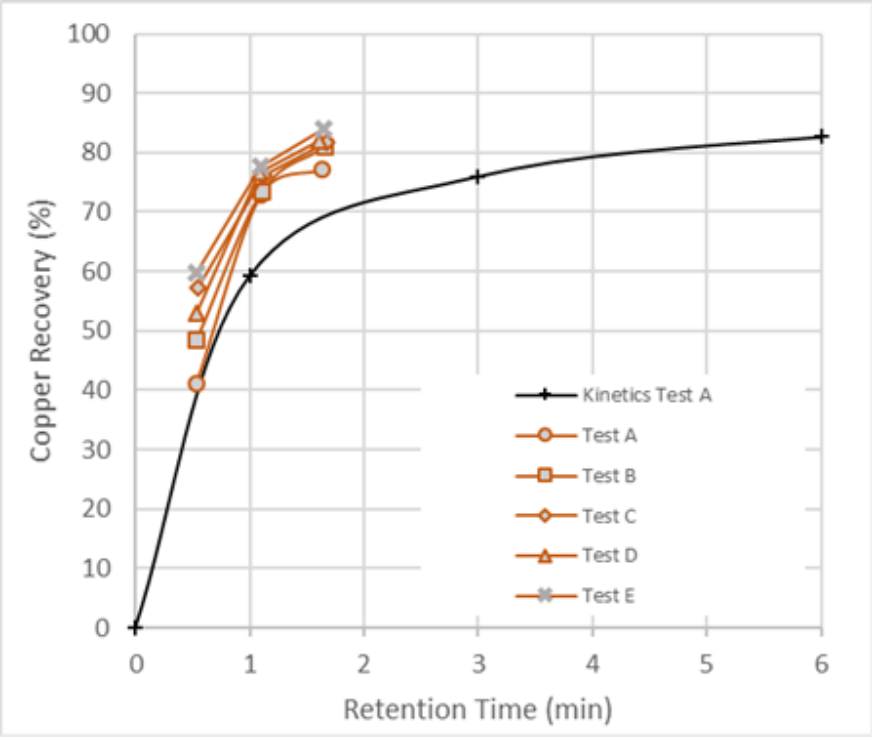
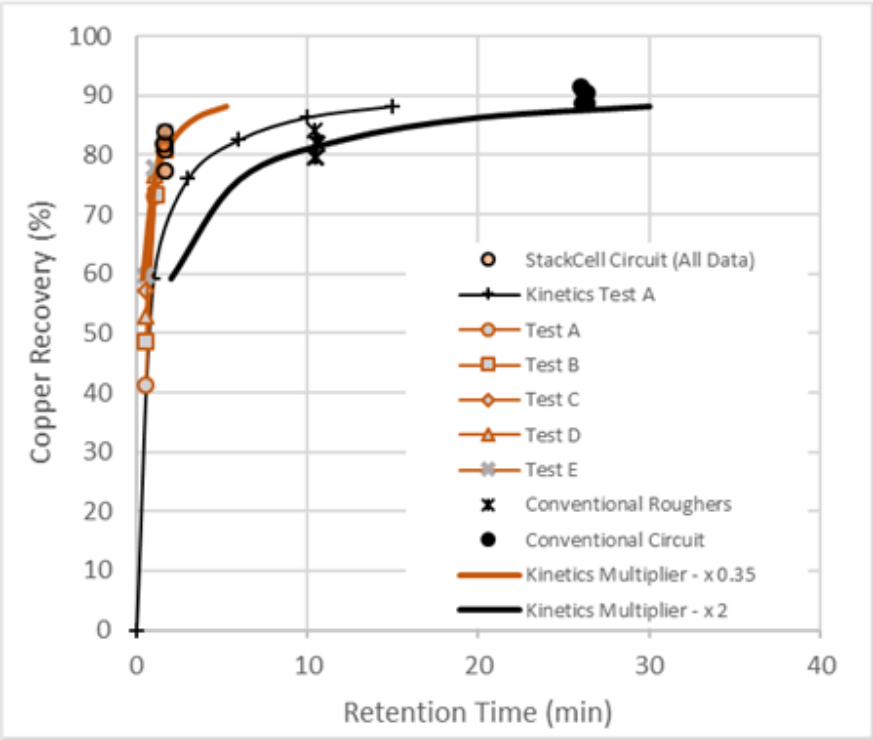
Flotation response





Comparison of StackCell, tank cell and Denver

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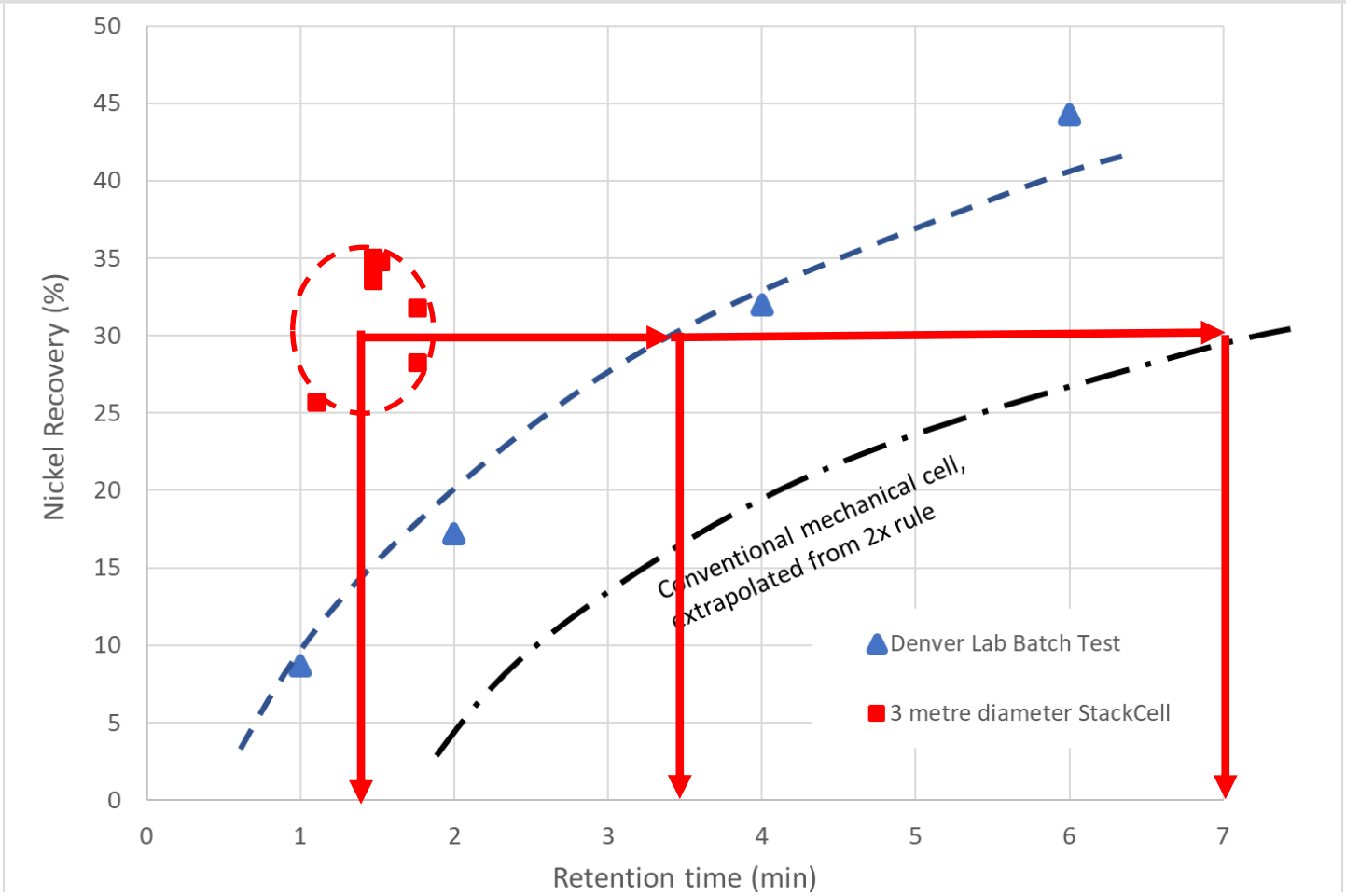
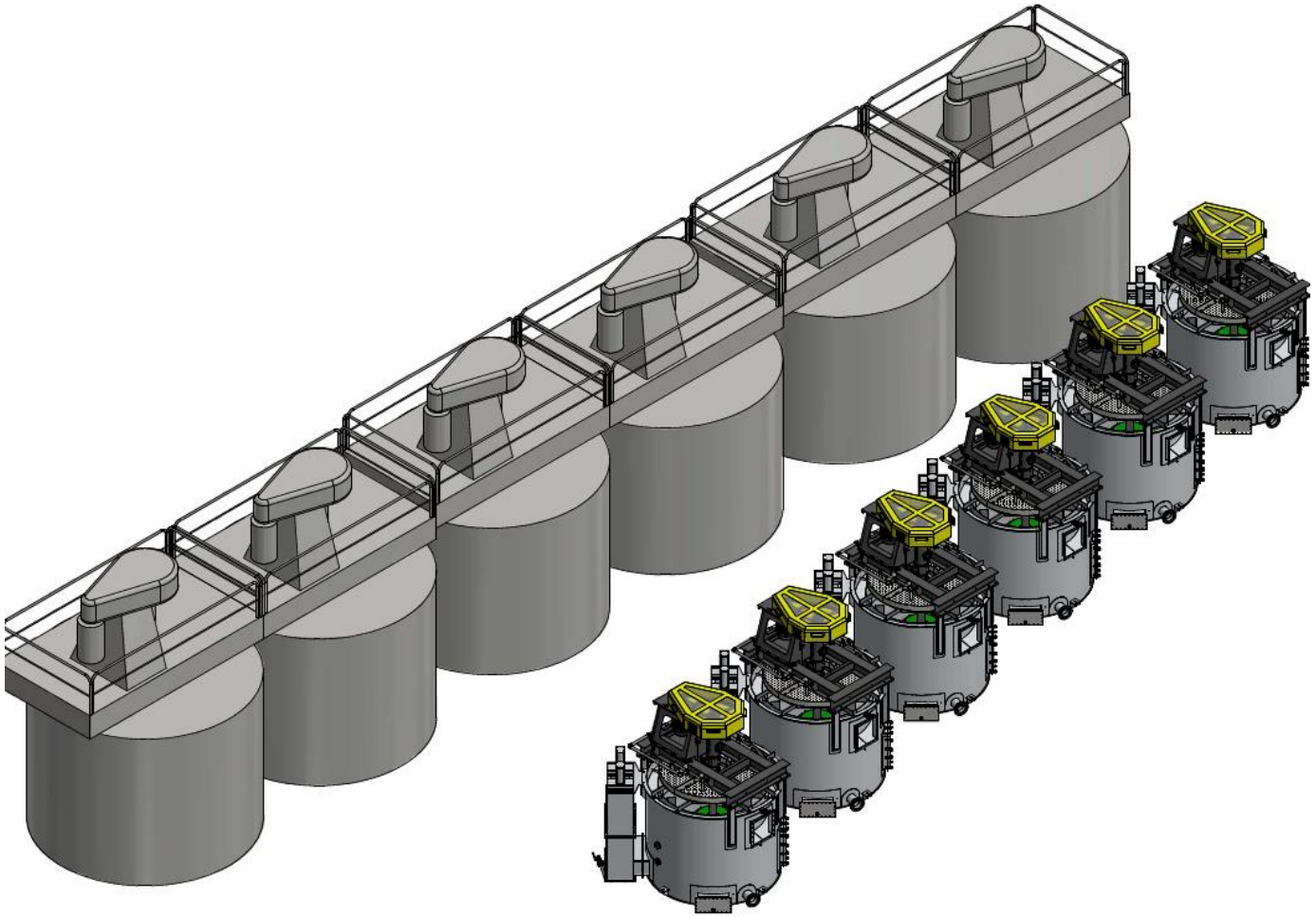
Flotation type	Cumulative Recovery (%)	Combined Grade (%Cu)	Time (min)
StackCell	79.9	14.6	1.9
Conventional cell	78.3	15.5	11.8
Denver	80.2	17.6	6.0

SC-70 StackCell™ in Ni cleaner application



Flotation volume reduced by 5x

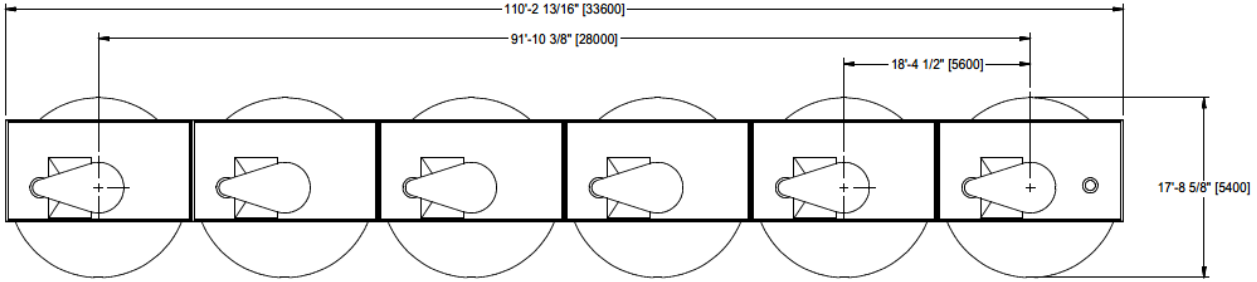
Benchmarking plant savings



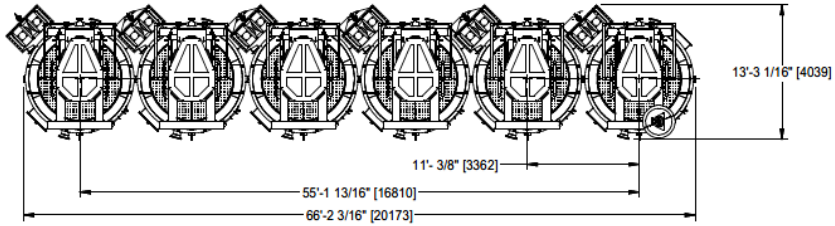
By reducing required volume 5x, equivalent metallurgy can be achieved in smaller footprint

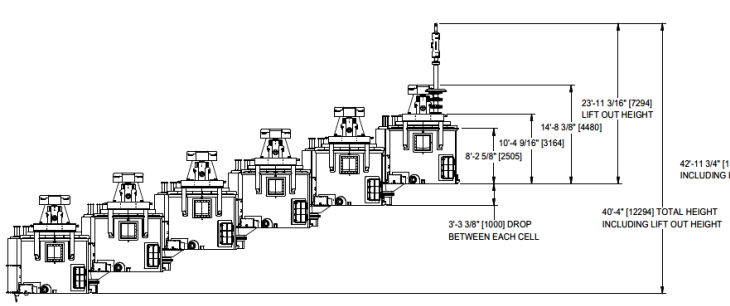
Economic benchmarking -basis

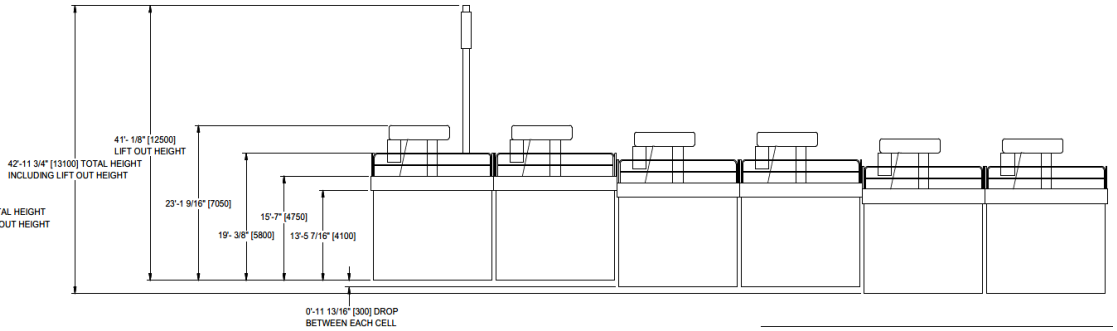
Generic 70 m^3 mech cells in 2-2-2 config. (300 mm step)



SC-70 in 1-1-1-1-1-1 config. (1,000 mm step)







Energy comparison

	Generic 70 m^3 mechanical cell	StackCell-70		
		Internal tank	Outside tank	Combined
Metallurgical performance	X	X		
Flotation volume [m^3]	70	relatively small		15
Installed power [kW]	90	56	0	56
Installed specific power [kW/m^3]	1.3	>100x	0	4.0

- Installed power of StackCell ~38% less than equiv. mech cell
- Specific power of StackCell >100x higher in collection zone and zero in froth recovery zone

Layout comparison

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	Generic 70 m^3 mechanical cell	StackCell-70
Metallurgical performance	X	X
Total height [mm]	7,100	4,100
Total height required to lift-out mechanism [mm]	13,100	12,300
Total diameter [mm]	4,400	5,400
Total length [mm]	33,600	21,200
Total footprint for train of 6 cells [m^2]	180	86
Total envelope for train of 6 cells [m^3]	2,400	1,100

- Total length of train ~37% less than equiv. mech cell
- Total volume and footprint ~ 50%

Foundation load comparison

	Typical 70 m^3 mechanical cell	StackCell-70
Metallurgical performance	X	X
Total unloaded weight [t]	17	8
Loaded with water [t]	90	23
Loaded with pulp, SG = 1.2 [t]	100	26
Train weight with pulp [t]	600	160

- Weight of loaded StackCell ~25% of equiv. mech cell

Conclusions

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- Two stage unit operation is a step change improvement in industrial flotation efficiency
- Two industrial comparisons with base metal sulfides indicates ~5x faster kinetics compared with conventional mech cells
- Benchmarking against mech cells shows power reduction of almost 40%, reduction in foundation loads of 4x, and reduction in footprint and envelope of 2x