

Case Study: Sacle-up of an EFD Flotation Column for Copper Cleaning



Updated Nov 2016

Outline

1. Background: Sandfire's DeGrussa Copper
2. Technical challenge with flow-sheet
3. Eriez' CavTube™ Sparged Column
4. On-site test-work
5. Results and conclusions

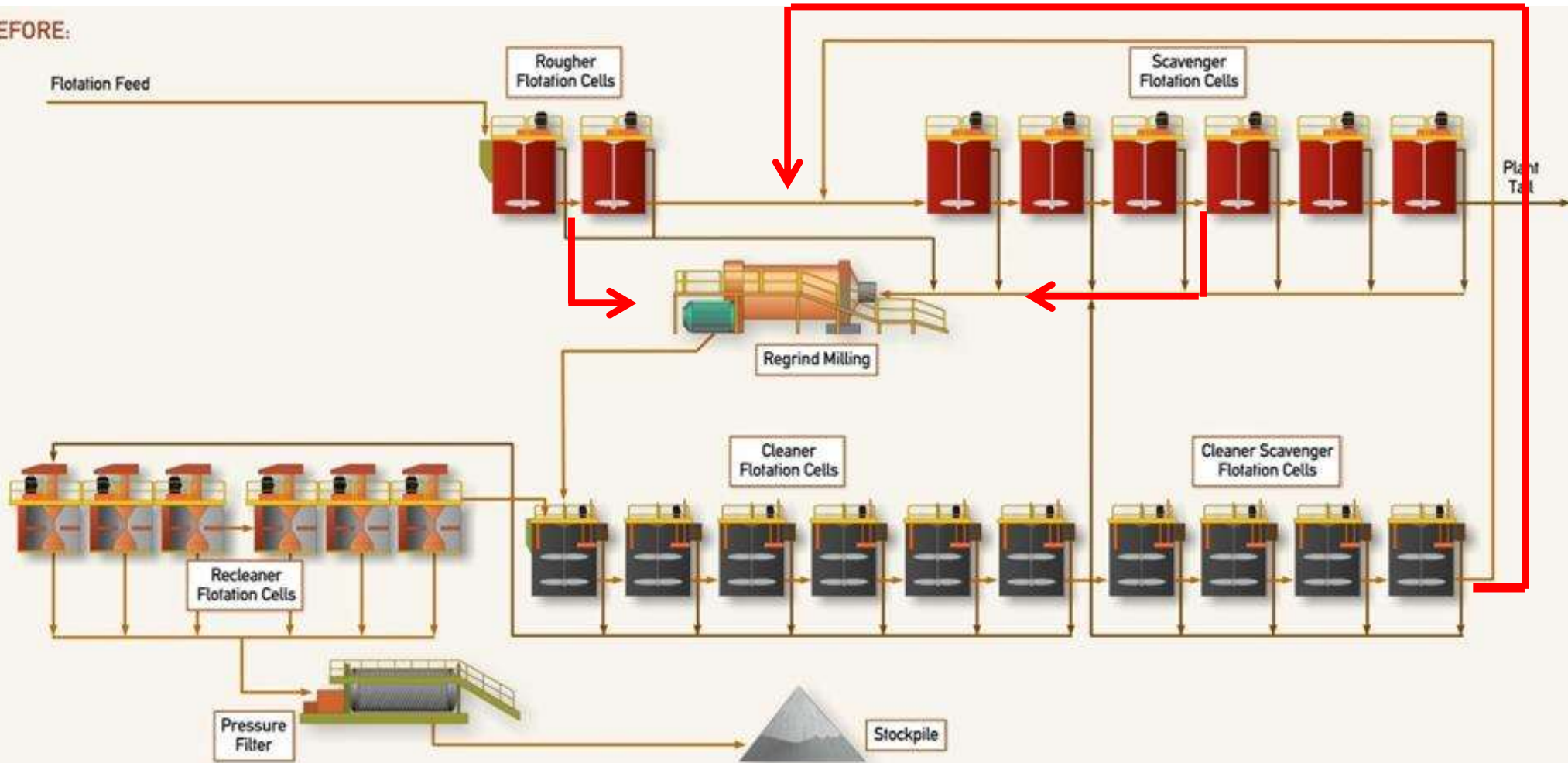
Sandfire's DeGrussa Copper



- Located in WA
- High-grade copper-gold sulfide mine
- 1.5 Mtpa concentrator commenced commercial production Sep 2012.
- Production up to 300,000 tonnes of high grade copper concentrate annually.

Concentrator Flowsheet-circa 2014

BEFORE:

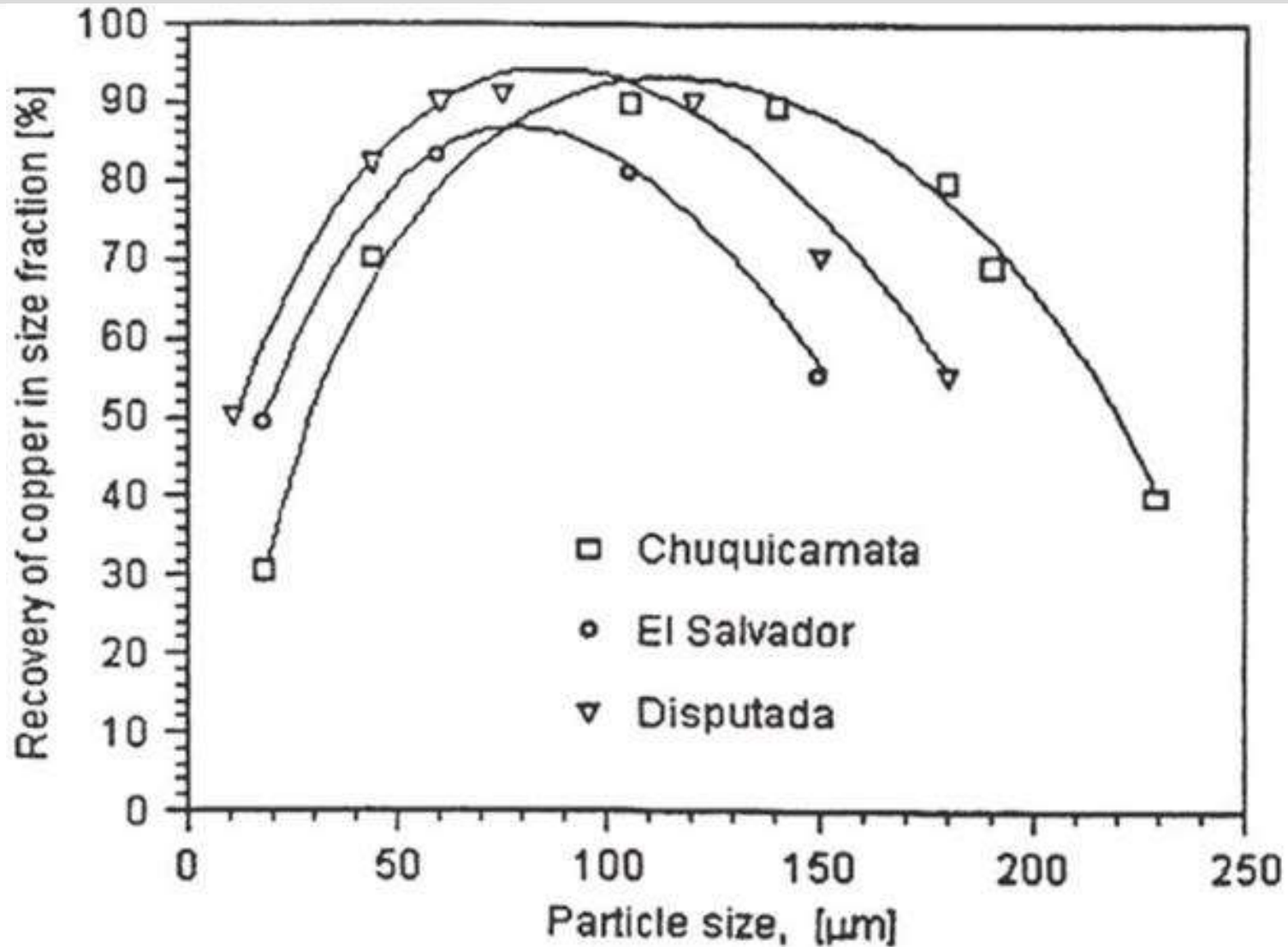


- 2 Ro – TC50
- 6 Scavs – TC50
- 6 CI - TC30
- 4 CI Scavs TC30
- 6 2nd CI OK16U

Challenges with original flowsheet

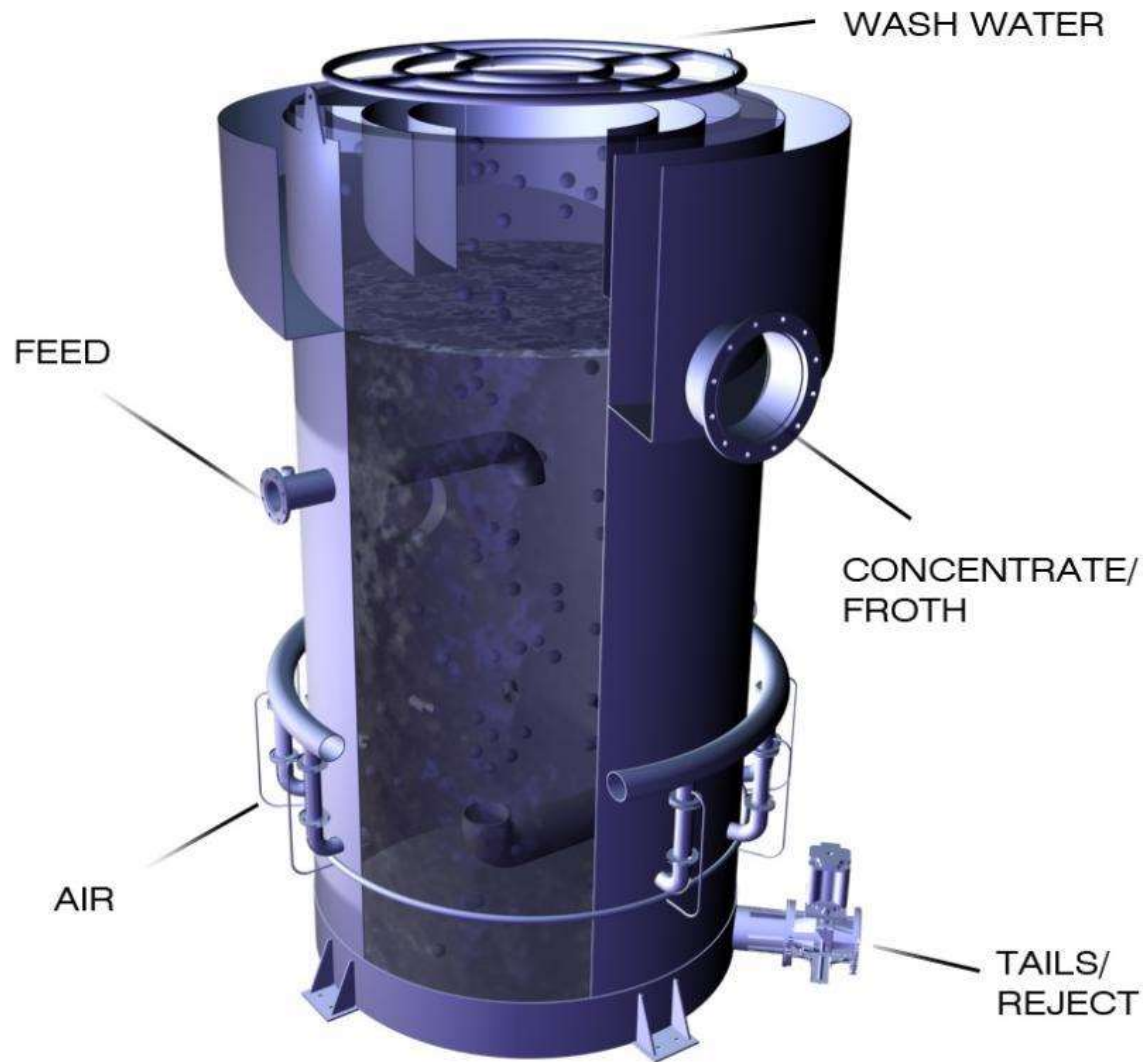
- All mechanical flotation cell circuit
- Rougher/scavenger recovery typically 91% with most losses $< 7 \mu\text{m}$ & $> 75 \mu\text{m}$
- Not able to meet the cleaner flotation requirements of the plant (re-grind $P_{80} \sim 18 \mu\text{m}$) because of poor selectivity at fine size
- Heavily loaded and sticky froth on the recleaner cells leads to poor concentrate grade, high NSG on the final copper concentrate grade from hydraulic entrainment.
- Significant circulating load required from cleaner scavenger cells back to rougher scavengers to enhance overall recoveries

Limitations of conventional flotation



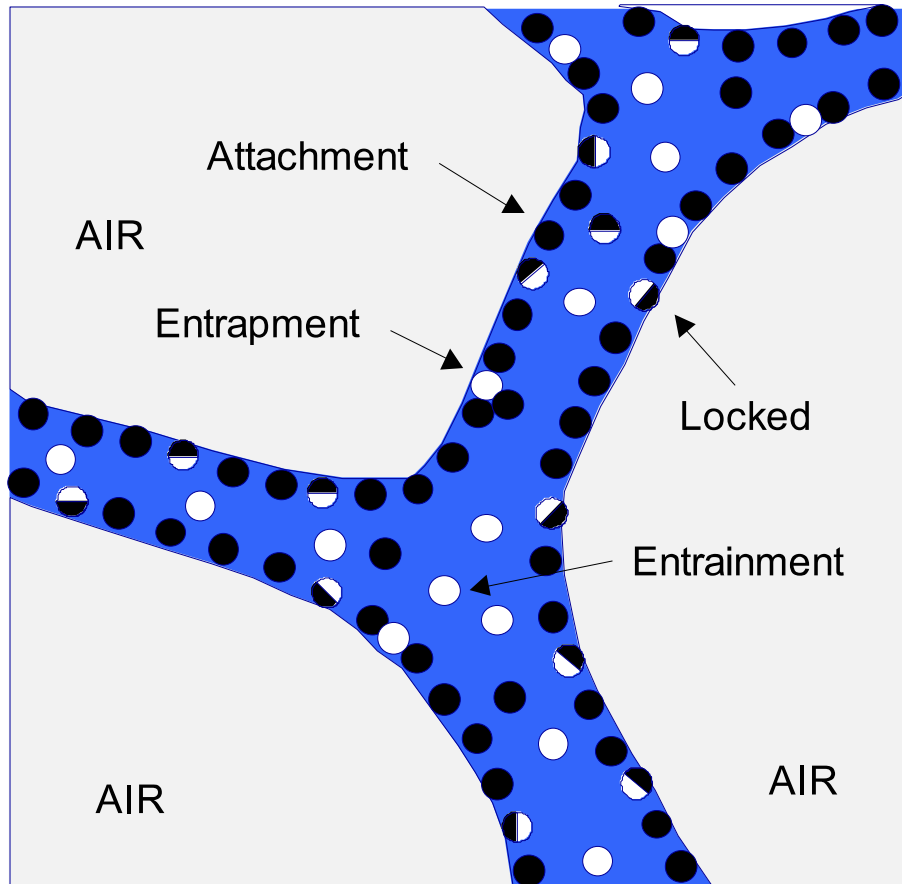
Flotation recovery by size for copper

Column Technology



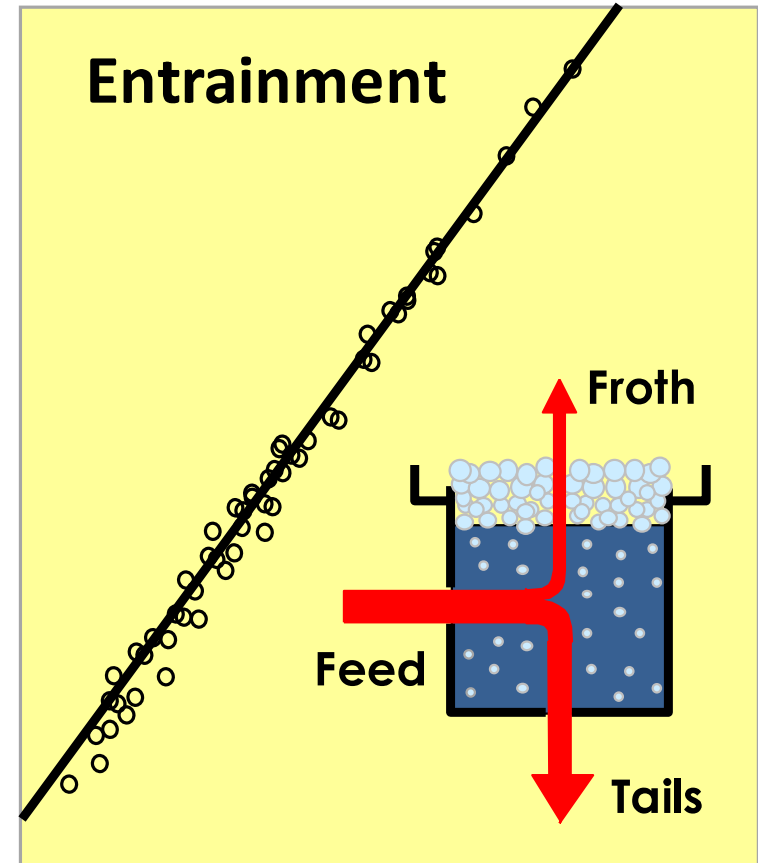
- Tall Tanks w/High Aspect Ratio, counter-current contacting
- Operate with Deep Froth
- Incorporates Uniform Froth Washing -better selectivity
- Low radial mixing, behaves more like PFR
- Sparging System
 - Heart of the Device
 - Produces High Surface Area Rates of Air for Collection of Hydrophobic Species.

Column Technology: Importance of wash water



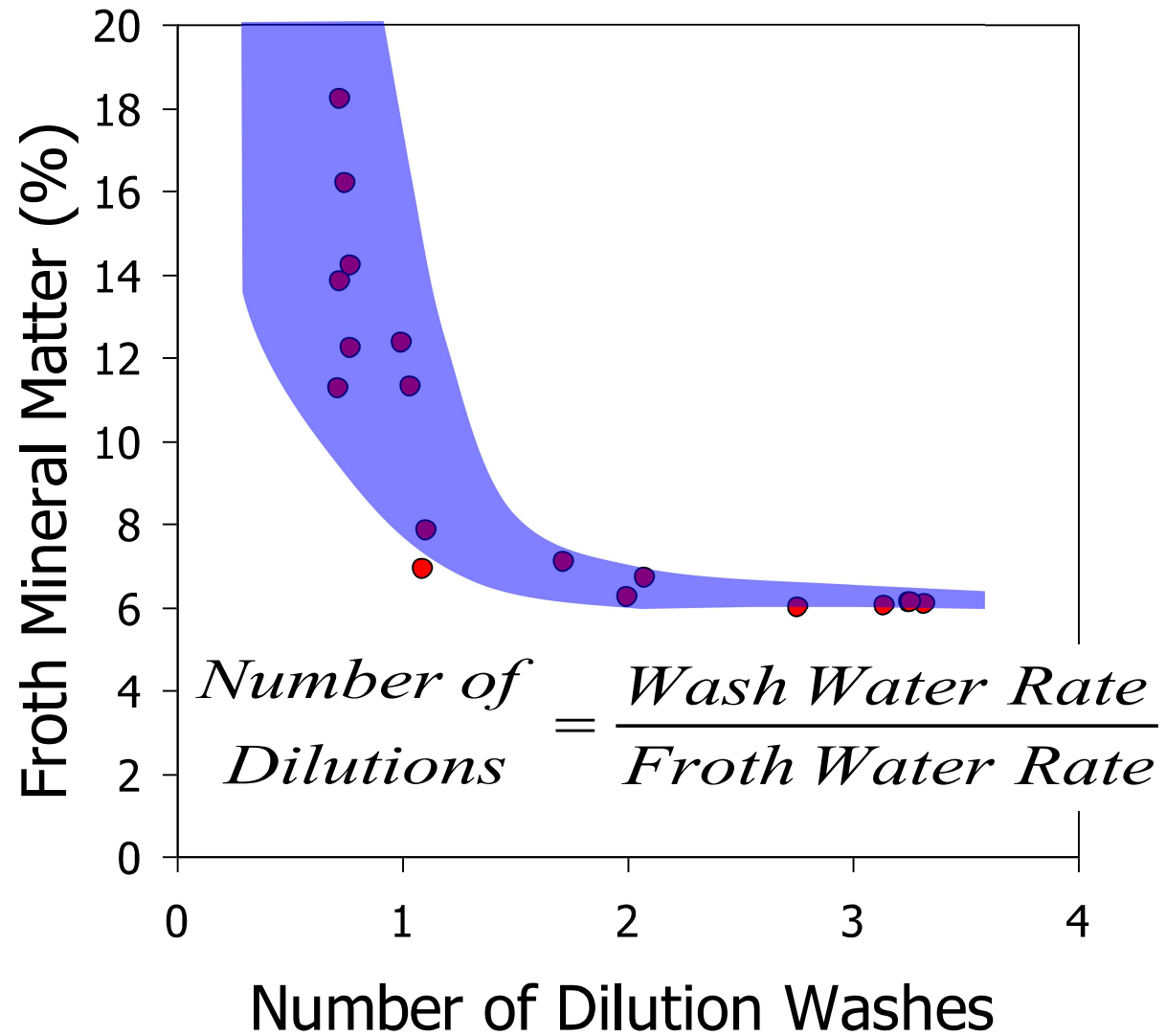
- VALUABLE
- ◐ MIDLING
- WASTE

Contaminant (tph)

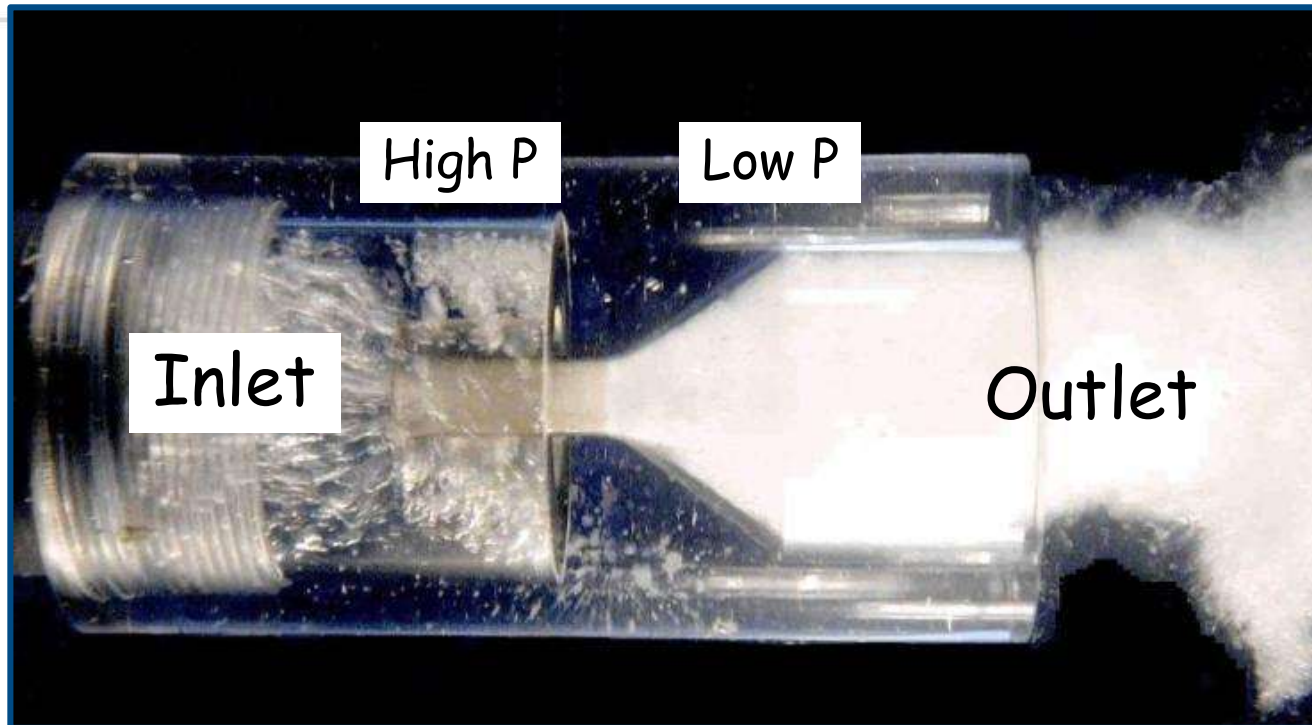


Froth Moisture (%)

Column Technology: Importance of wash water



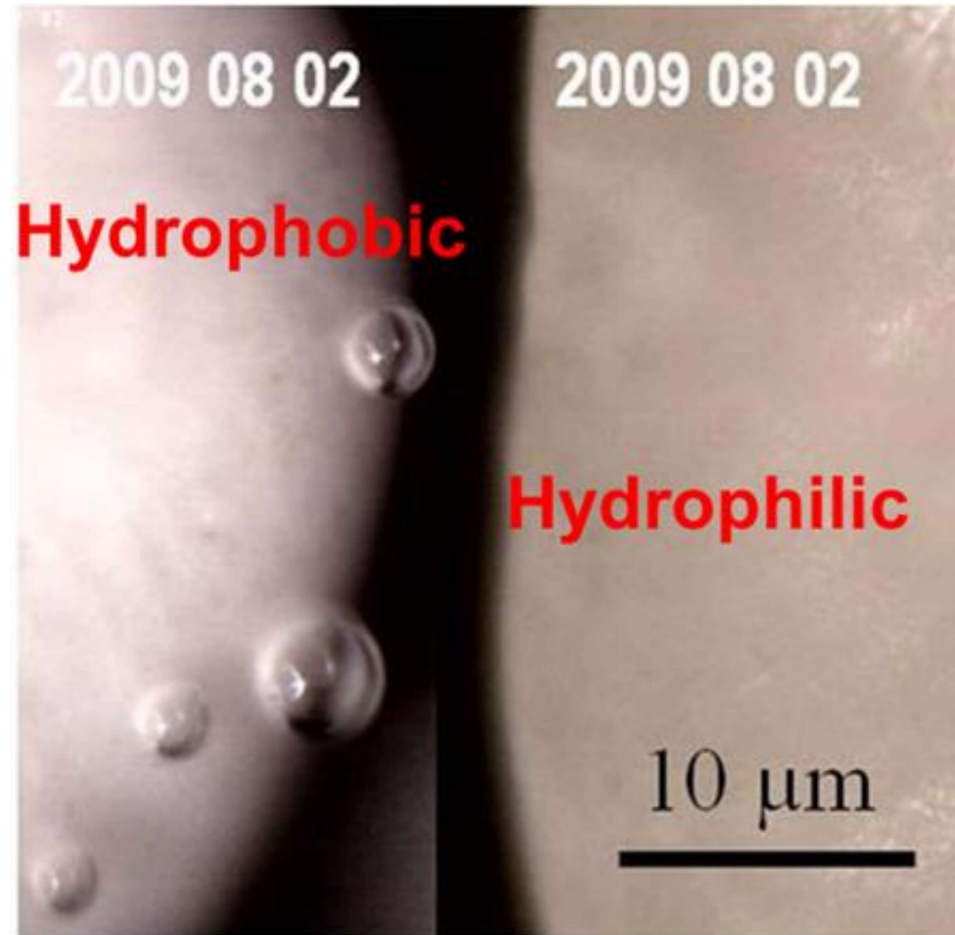
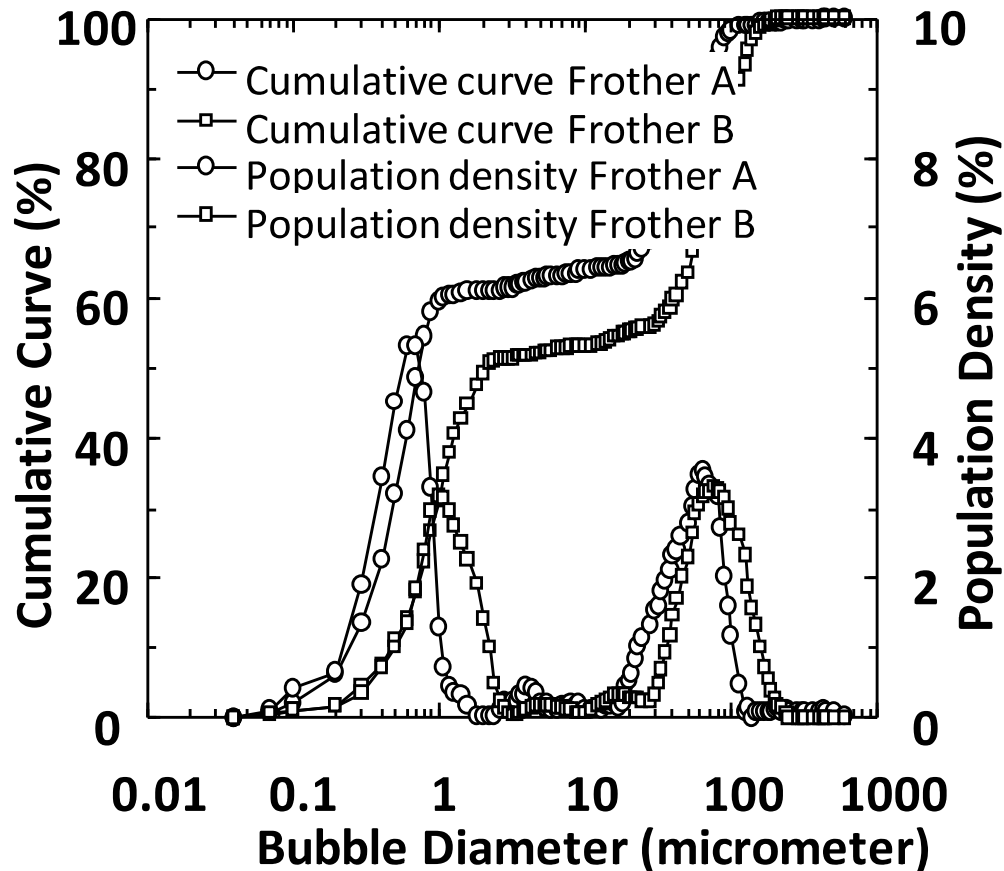
Making smaller bubbles- the CavTube®



Plexiglass model

- Contraction/ expansion nozzle
- Shatters sparged air into ~100 micron bubbles
- As pressure drops, ~ 1 micron bubbles are nucleated from the liquid phase and adsorb onto hydrophobic surfaces

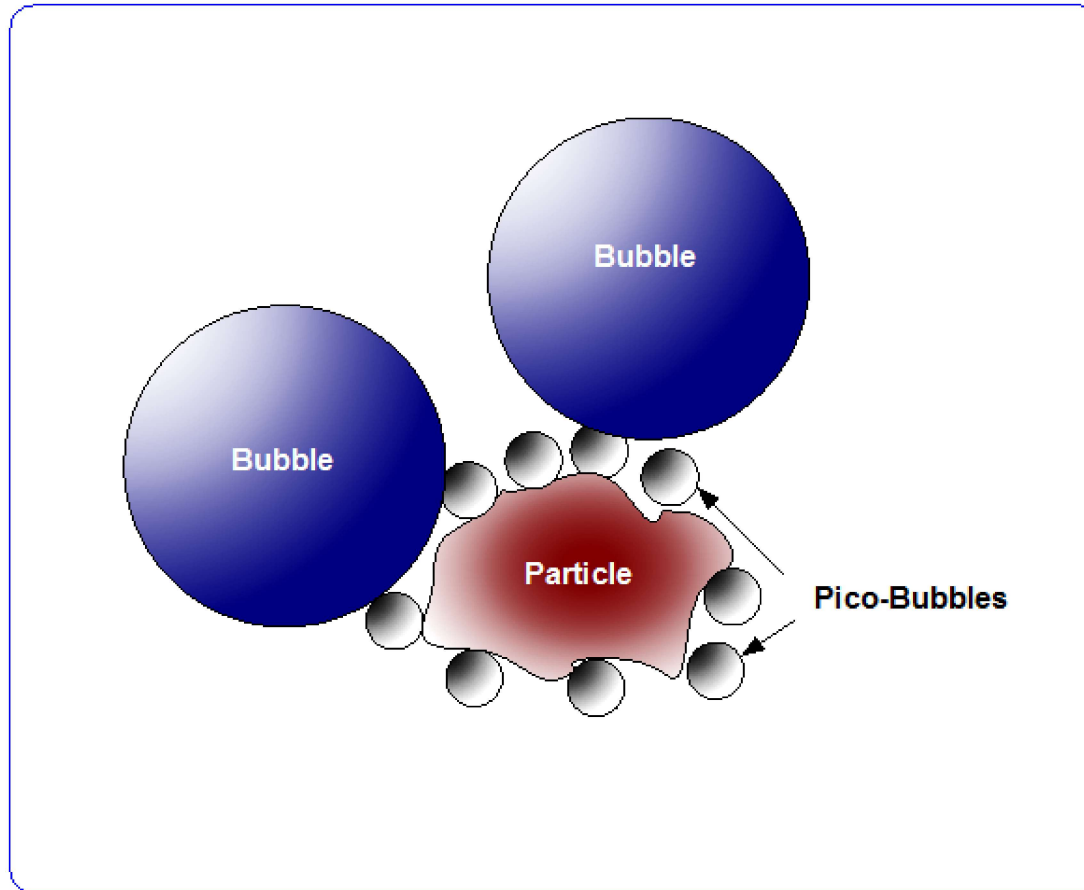
Bubble size distribution with air addition*



Note: for a typical application with $J_g = 0.75$ cm/sec, the nucleated bubbles are about 2% of total air volume added to cell

*Mining Sci. & Tech, 20 (2010), pp1-19

Probable mechanism for improved collection



1. Small bubbles preferentially nucleate on hydrophobic surfaces
2. Act to tether larger bubbles, ie improve sticking efficiency

Evaluation of column and scale-up



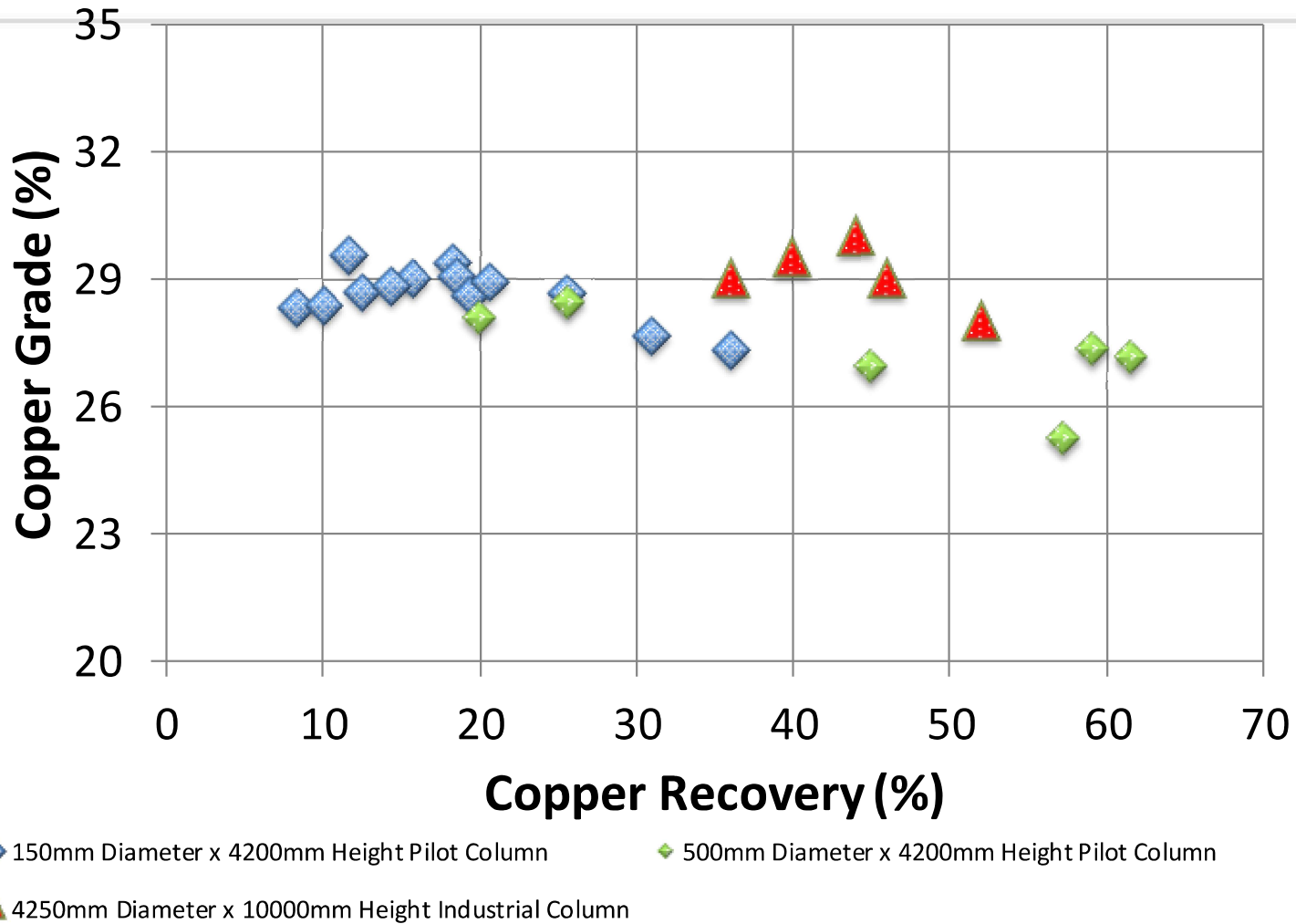
500 mm pilot unit at site



4250 mm full-scale unit

EFD did on-site test-work at DeGrussa with a lab-scale column (150 mm dia) and then a pilot-scale column (500 mm dia)

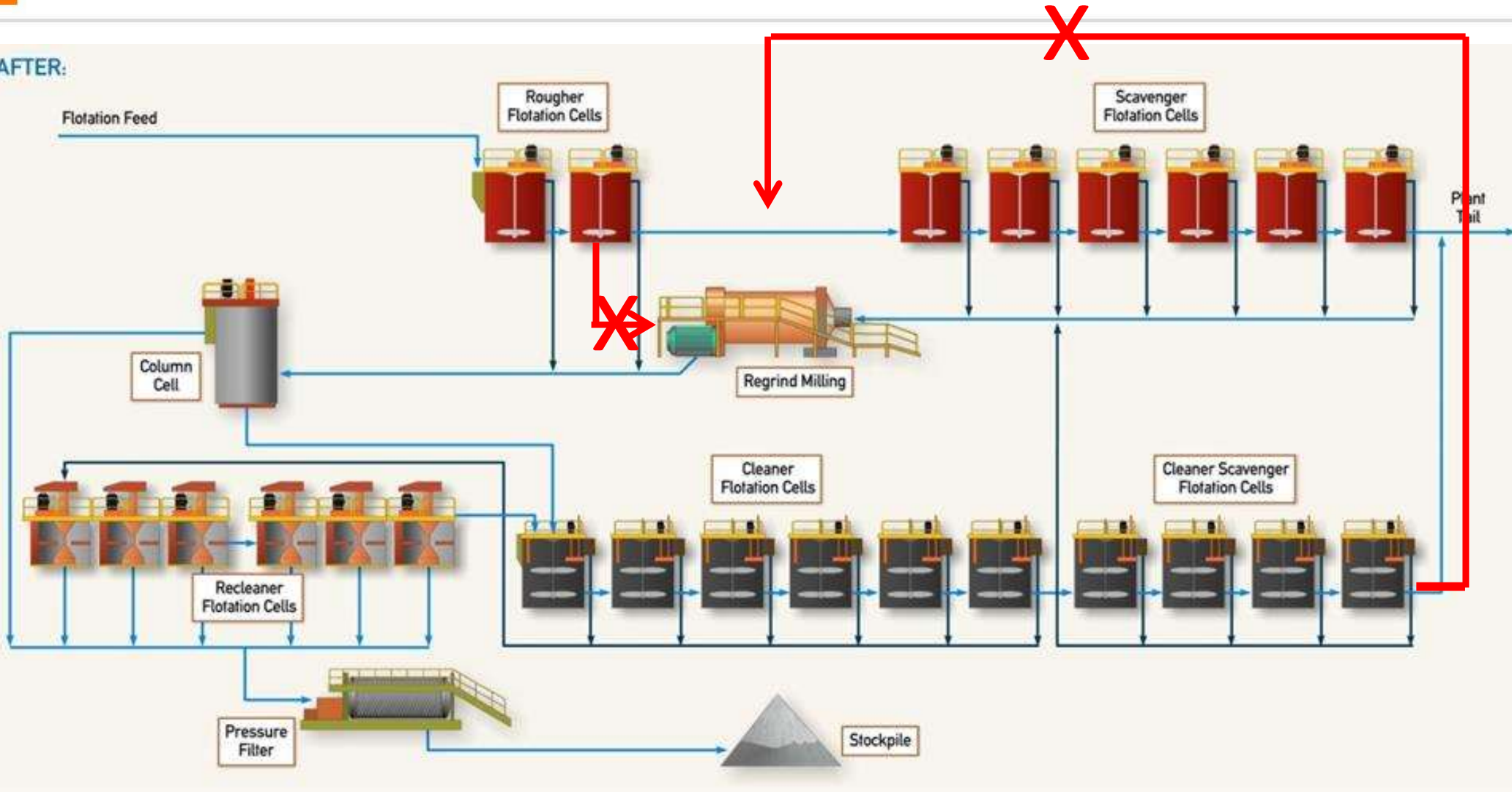
Results



Result of commercial column exceed pilot results!

Concentrator Flowsheet-circa 2015

AFTER:



Comparison: before and after

Circuit	Pre-Column Installation Survey 1 (2014)	Pre-Column Installation Survey 2 (2014)	Post Column Installation (2015)
Total Circuit Cu Recovery (%)	89.8	87.4	91.7
Cleaner Block Cu Recovery (%)	80	67	98.5
Column Cu Recovery (%)			64.2
Recleaner Cu Recovery (%)	85	82	53.3

- Circulating load from cleaner back to scavenger eliminated
- 4 out of 6 mechanical recleaner cells were taken offline.
- Significant improvement in global copper recovery 2-4%

Conclusions

- Conventional flotation cells are not optimal for all applications, especially with fine particles and fine gangue, similar result discovered at Cerro Corona (see Diaz et al, Flotation 2015)
- Scale-up of columns is possible and Lab/ pilot results can be met or exceeded in commercial operation.
- Comments from Sandfire management one month after commissioning the column **“The column flotation cell in particular has delivered some positive early results, suggesting that the original recovery improvement target of about 1% may be exceeded.”** (Sandfire CEO Karl Simich, Mining News Feb 26, 2015)
- DeGrussa now doing test-work to add another column