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Phosphate in Australia

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Column Flotation of Phosphate Ore

An Engineer's Perspective

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- Introduction
- Comparison of technologies
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Introduction

Something to think about…….

Is the use of column flotation a forgotten or overlooked process option for flotation of fine phosphate ores?

Introduction (Cont.)

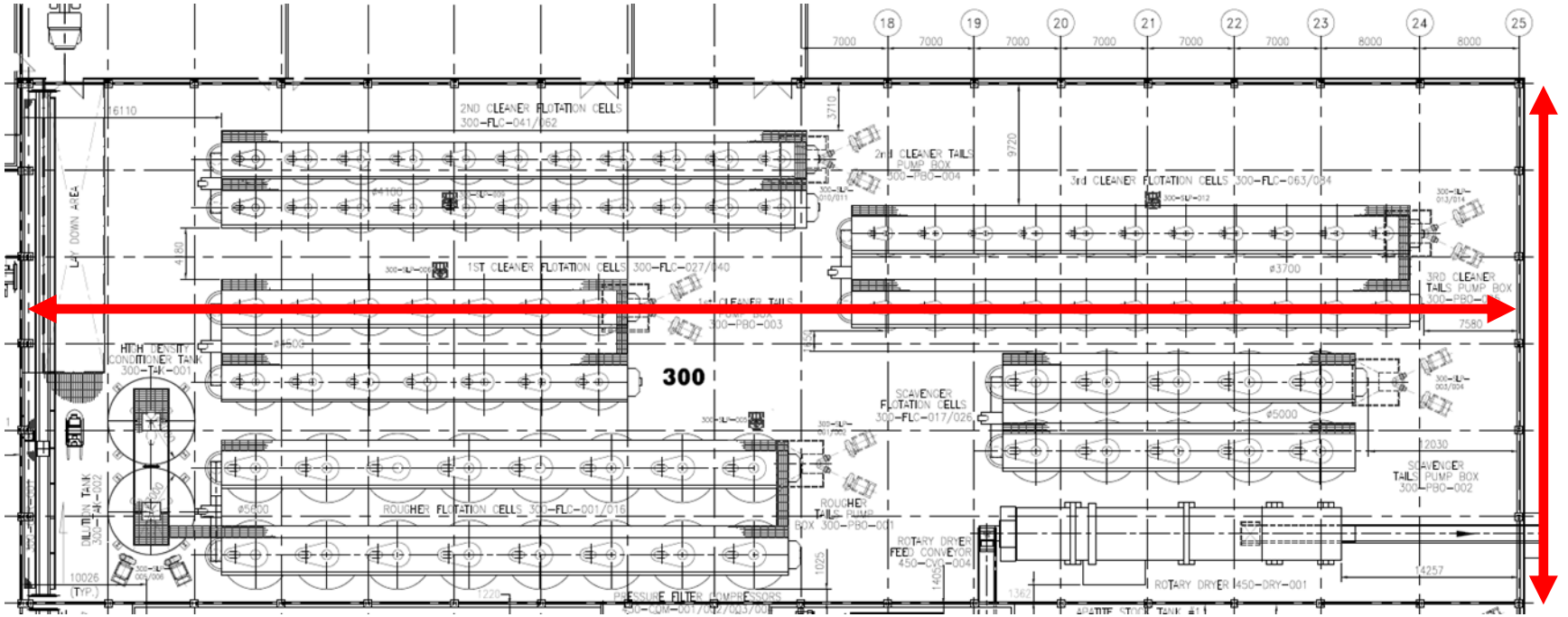
- Use of columns first recognised by Klassen and Mokrousov for froth washing in early 1960's.
- Boutin and Wheeler claim to have commercialised column flotation at Opemiska, Canada
- Columns have been in use in phosphate beneficiation since the 1980's
- Used for both sedimentary and igneous phosphate
- Finer particle sizes better suited to column flotation (<212µm)
- Columns are able to treat ultra fine particles (>10µm to <38µm)

Comparison of Technologies – Mechanical Flotation

Mechanical

- Agitator drive required per cell
- Bubbles generated by shear at the rotor and stator
- Larger bubble size
- Larger foot print
- Require more stages to achieve grade and recovery

Comparison of Technologies – Mechanical Flotation (Cont.)

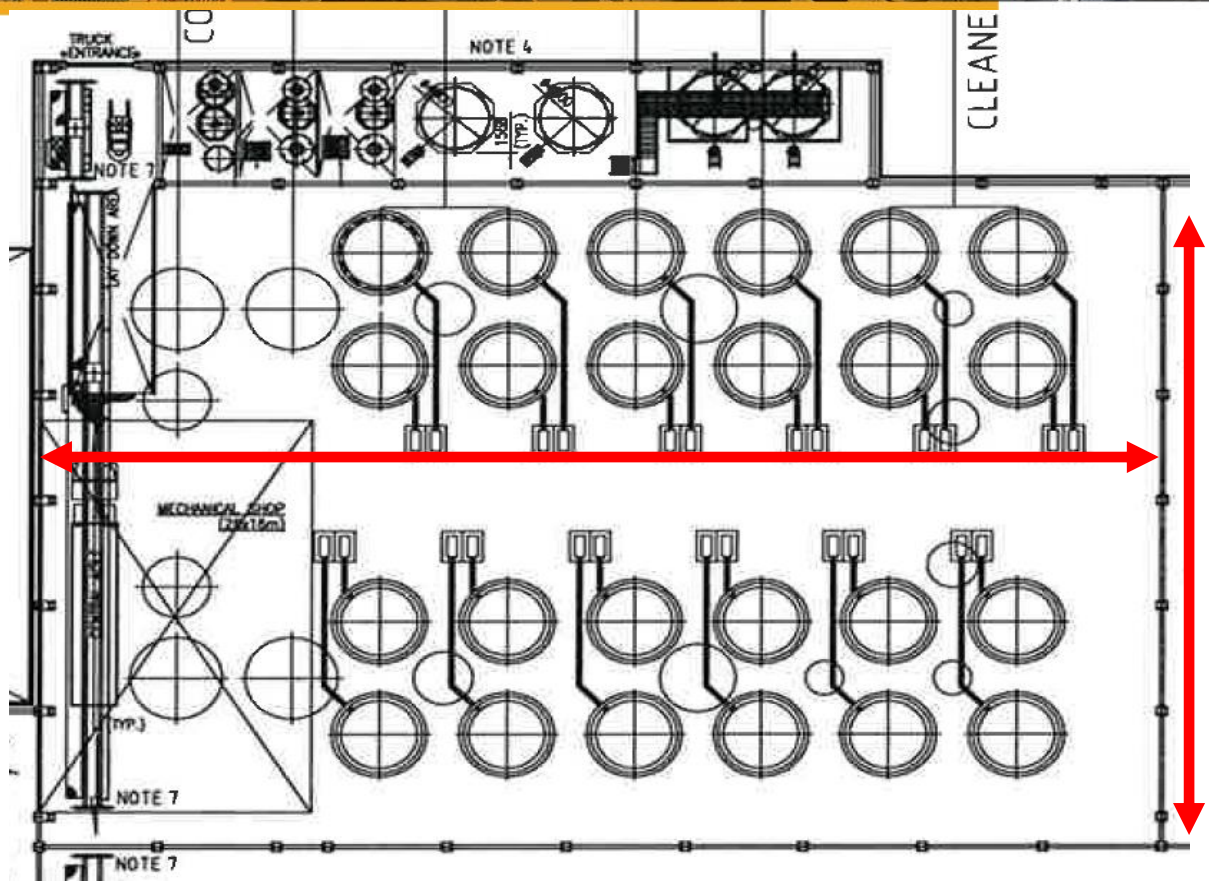


- Mechanical flotation circuit layout
- Structural column centres are 7m
- **120m (L) x 42m (W) = 5040m²**

Comparison of Technologies – Column Flotation

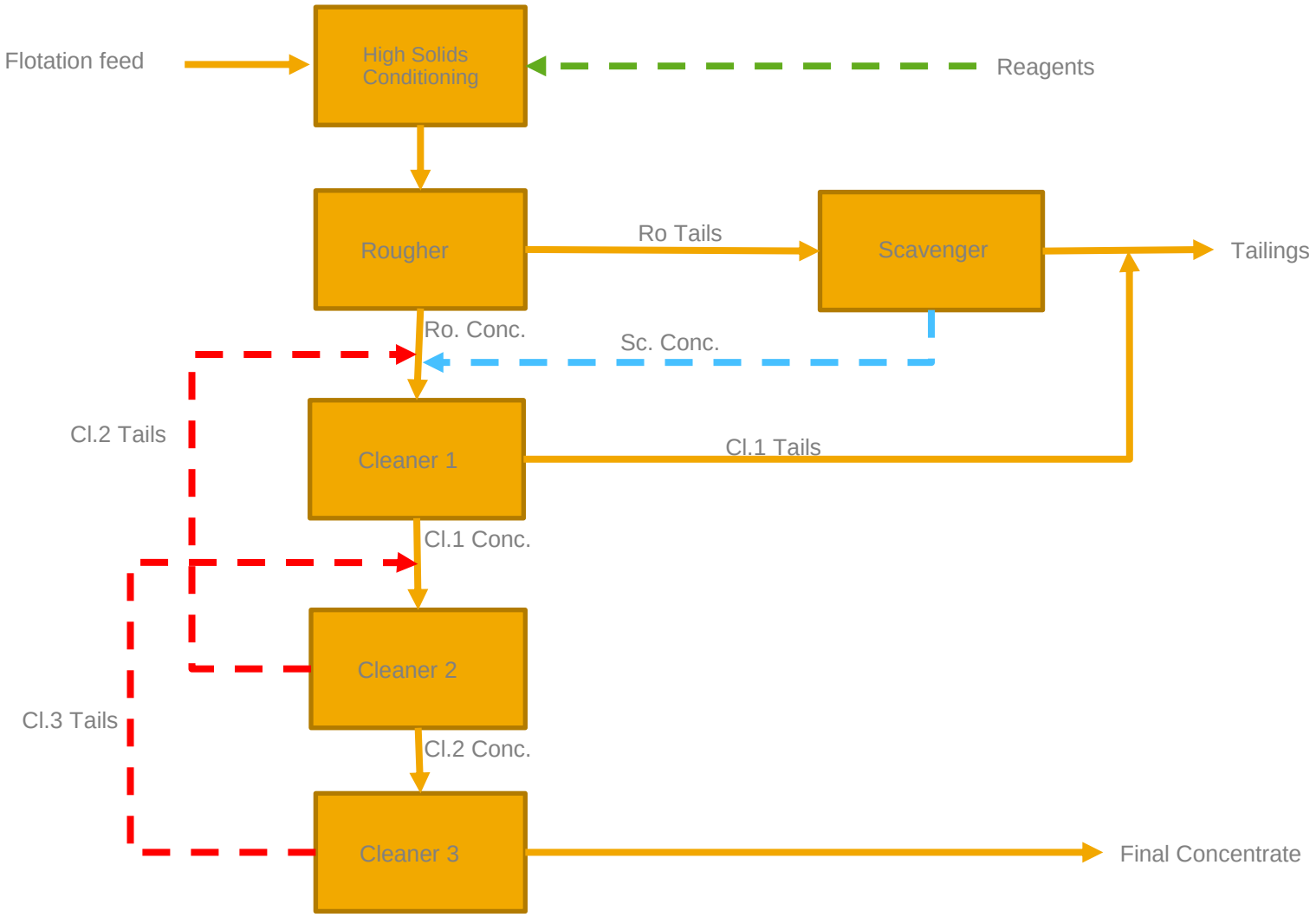
- **Columns**
  - No agitator (recirculation pump)
  - Deeper, more stable froth
  - Finer bubble size
  - External bubble generator
  - Requires less stages to achieve grade and recovery

Comparison of Technologies – Column Flotation (Cont.)

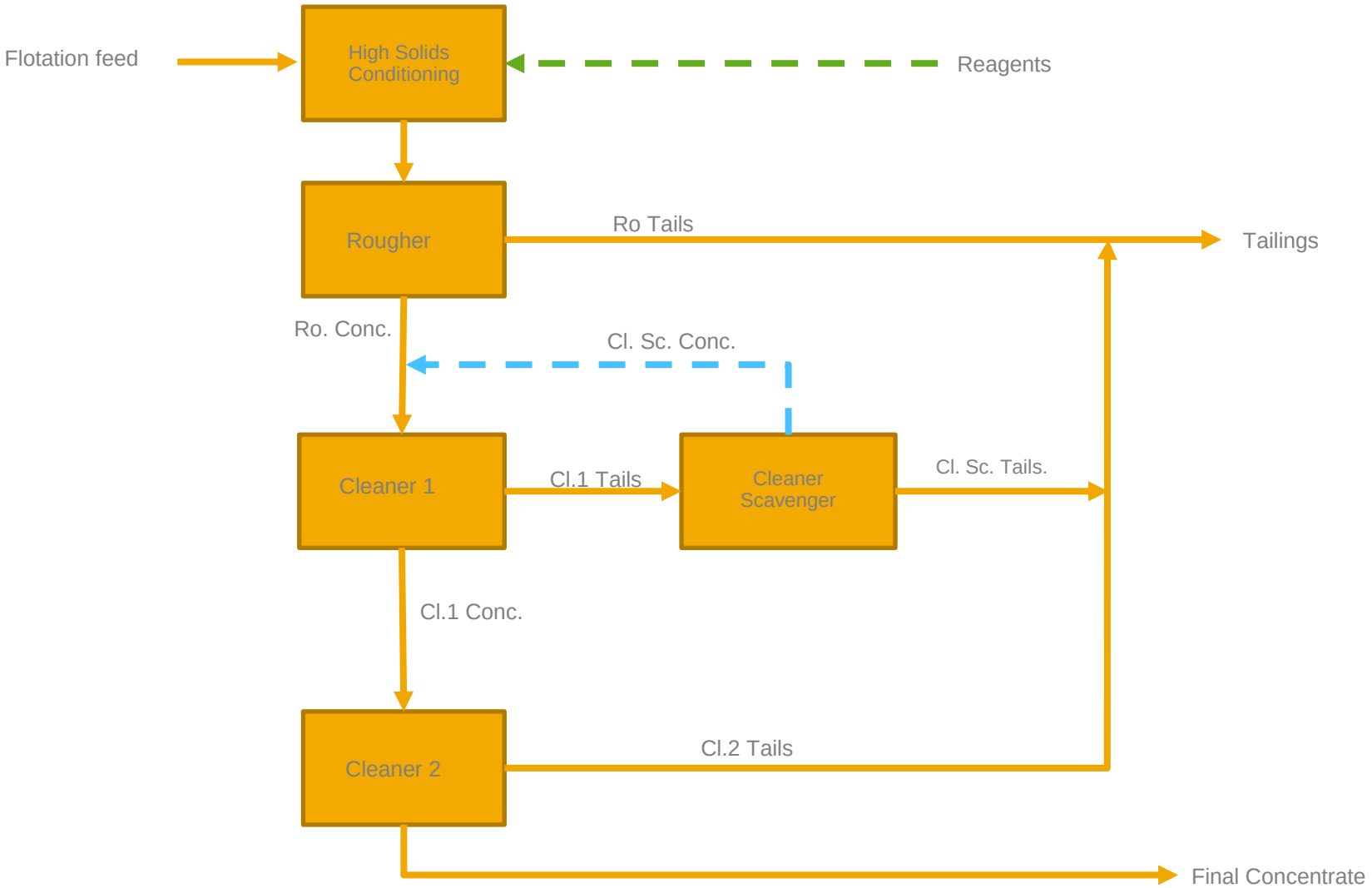


- Column flotation circuit layout
- Structural column centres are 7m
- **70m (L) x 42m (W) = 2940m²**

Typical Pilot Plant Flow Sheet - Mechanical



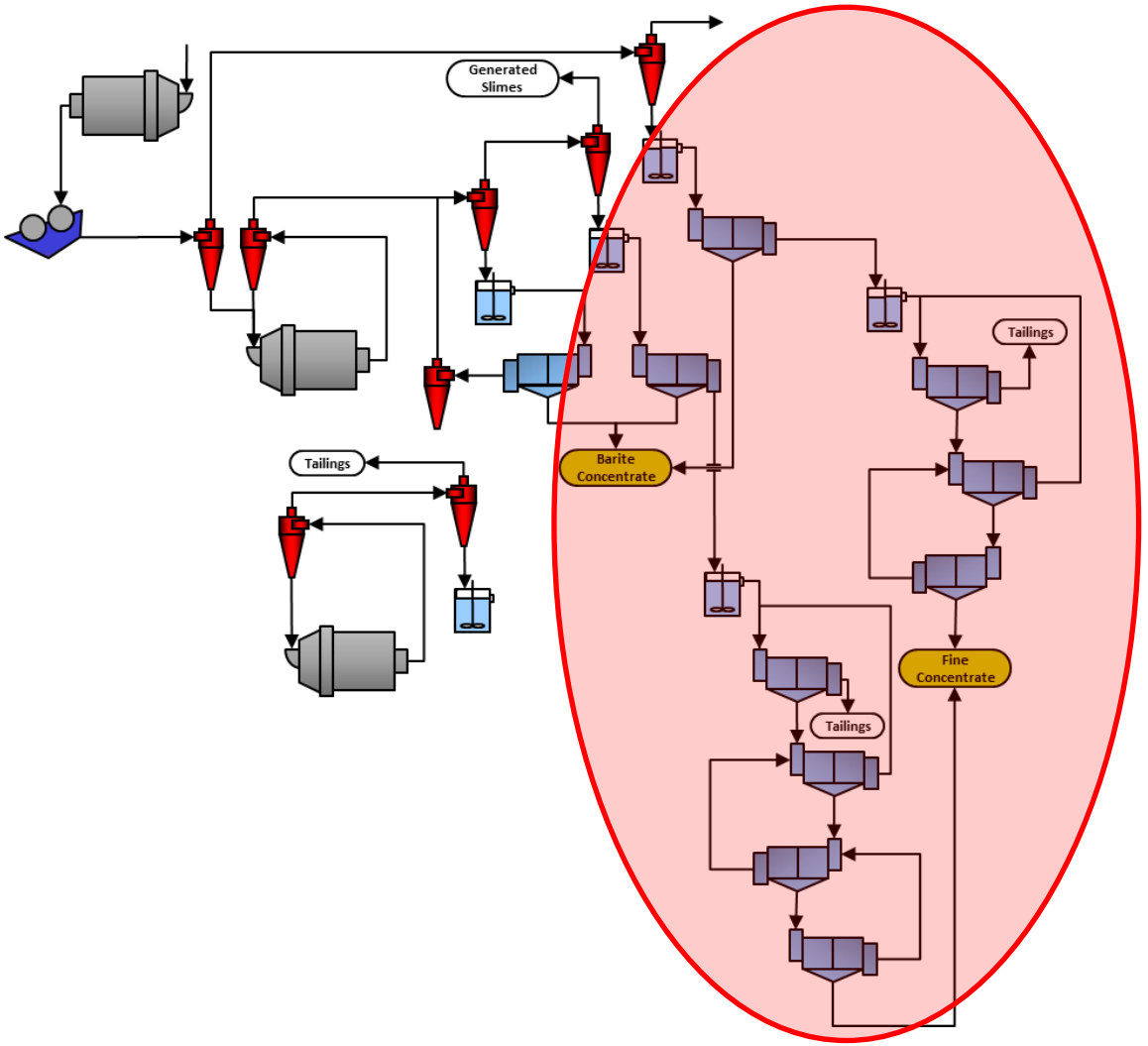
Typical Pilot Plant Flow Sheet - Columns



Typical Phosphate Mechanical Flotation Circuit

Based on Brazilian igneous phosphate plant
(0.250mm x 0.030mm)

- 10m^3 cells
- 66 float cells
- 17 cleaner cells
- 11 recycle streams

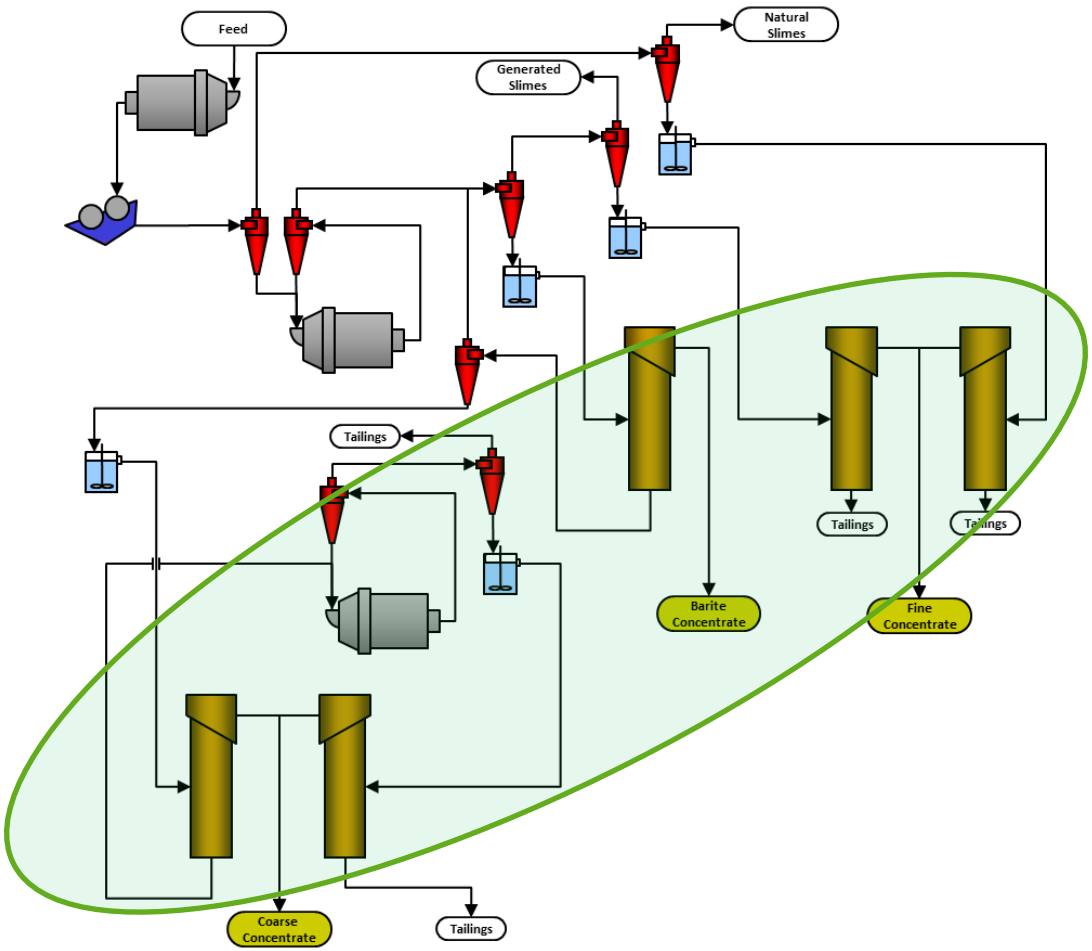


Source: Eriez Flotation Group 2013

Typical Phosphate Column Flotation Circuit

Based on a Brazilian igneous phosphate plant
(0.250mm x 0.030mm)

- 195m^3 columns
- 6 columns
- 5 stages of cleaners
- 0 recycle streams



Source: Eriez Flotation Group 2013

Review of technical benefits

Type	Stages in circuit	Trains	Installed Power (kW)	No. of cells	Design Volume (m^3)
Mechanical	5	2	5962	84	4176
Columns	4	2	3896	28	6135
	<1		**<2066**	**<56**	**>1959**

- Basis:
  - 2400tph flotation feed
  - Igneous rock
  - Mechanical cells as per vendor recommendations (non-standard sizes for phosphate beneficiation (100m^3, 75m^3 and 50m^3 units)
- Benefits
  - Circuit layout
  - Number of flotation cells required

Review of technical benefits (Cont.)

Type	Stages in circuit	Trains	Installed Power (kW)	No. of cells	Design Volume (m^3)
Mechanical	5	2	9088	246	4176
Columns	4	2	3896	28	6135
	<1		**<5192**	**<218**	**>1959**

- Basis:
  - 2400tph flotation feed
  - Igneous rock
  - Mechanical cells resized as per industry practice
  - Number of cells is based on $20m^3$ or $600ft^3$ sized units
- Benefits
  - Circuit layout
  - Number of flotation cells required

Review of technical benefits (Cont.)

- Metallurgical testwork results

Type		Recovery		Conc. Grade $\%P_2O_5$
Test	Cell type	Mass	P_2O_5	
Pilot	Mechanical	23.4	78.2	32.4
Pilot	Column	17.6	91.6	38.6
Pilot	Mechanical	11.7	63.7	37.1

Economic benefits

- Based on flowsheets as previously discussed
- Capital costs
- Operating costs

Economic benefits (Cont.)

- Capital costs
  - Less flotation columns required to treat same volume throughput
  - Less mechanical drives required
  - Less electrical drives
    (no agitators and associated drives in MCC)
  - Savings in circuit foot print (Reduced floor space but increase in building height)
  - Savings in steelwork and concrete

Economic benefits (Cont.)

- Operating costs
  - Savings in unit power consumption (kWh/t)
  - Savings in mechanical equipment maintenance
  - Less equipment to supervise / manage

Concluding comments

- As phosphate ore deposits require more liberation (finer particle size) to remove deleterious elements so column flotation will become more prominent
- There are various suppliers of non agitated flotation machines – Eriez, Metso Cisa, MBE (Pnueuflot) and Maelgwyn Mineral Services (Imhoflot)
- Proven metallurgical benefits when particle size range of flotation feed is less than 212µm
- Process desliming cut point can be reduced as columns can treat finer particle sizes in the deep stable froth beds
- Process testwork using columns usually starts in pilot scale as the bench scale columns do not produce representative results.

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