Ultrafine Flotation in Base Metals

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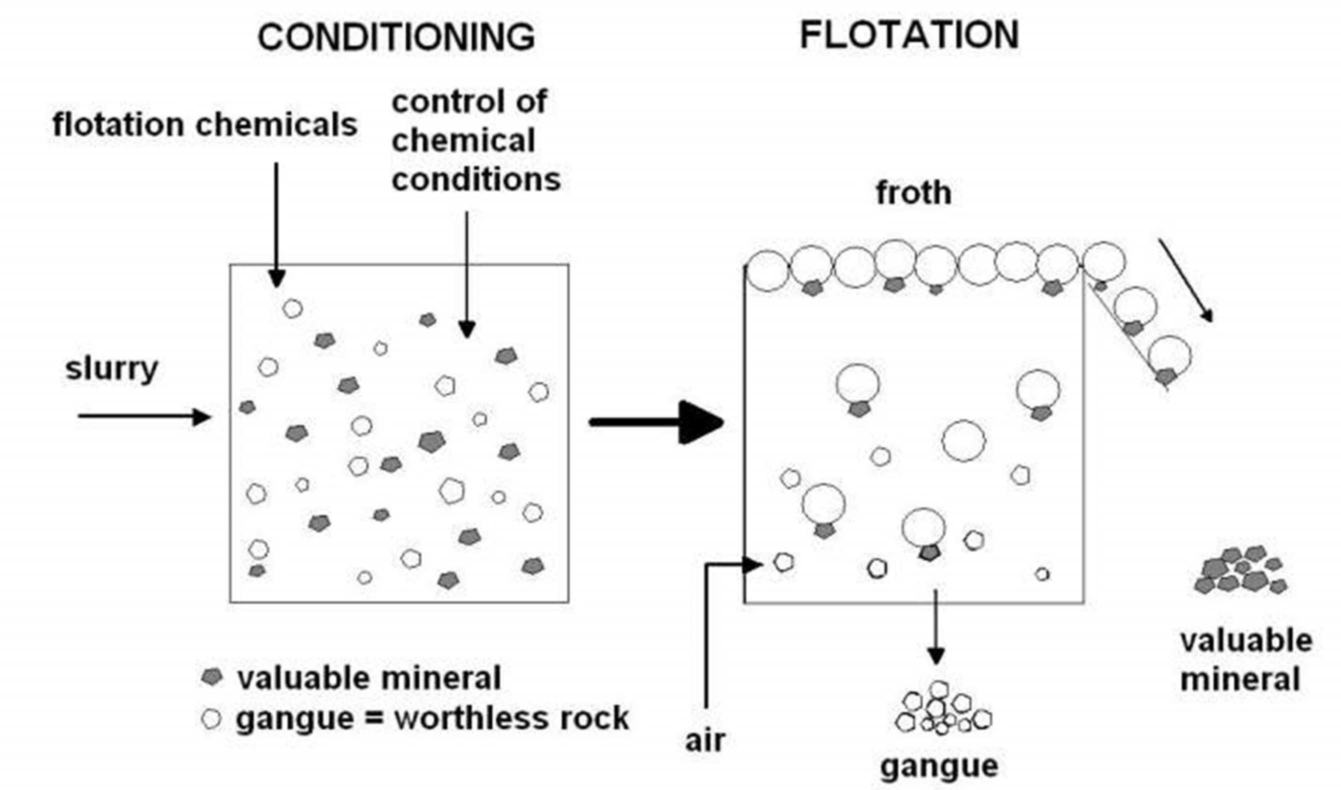
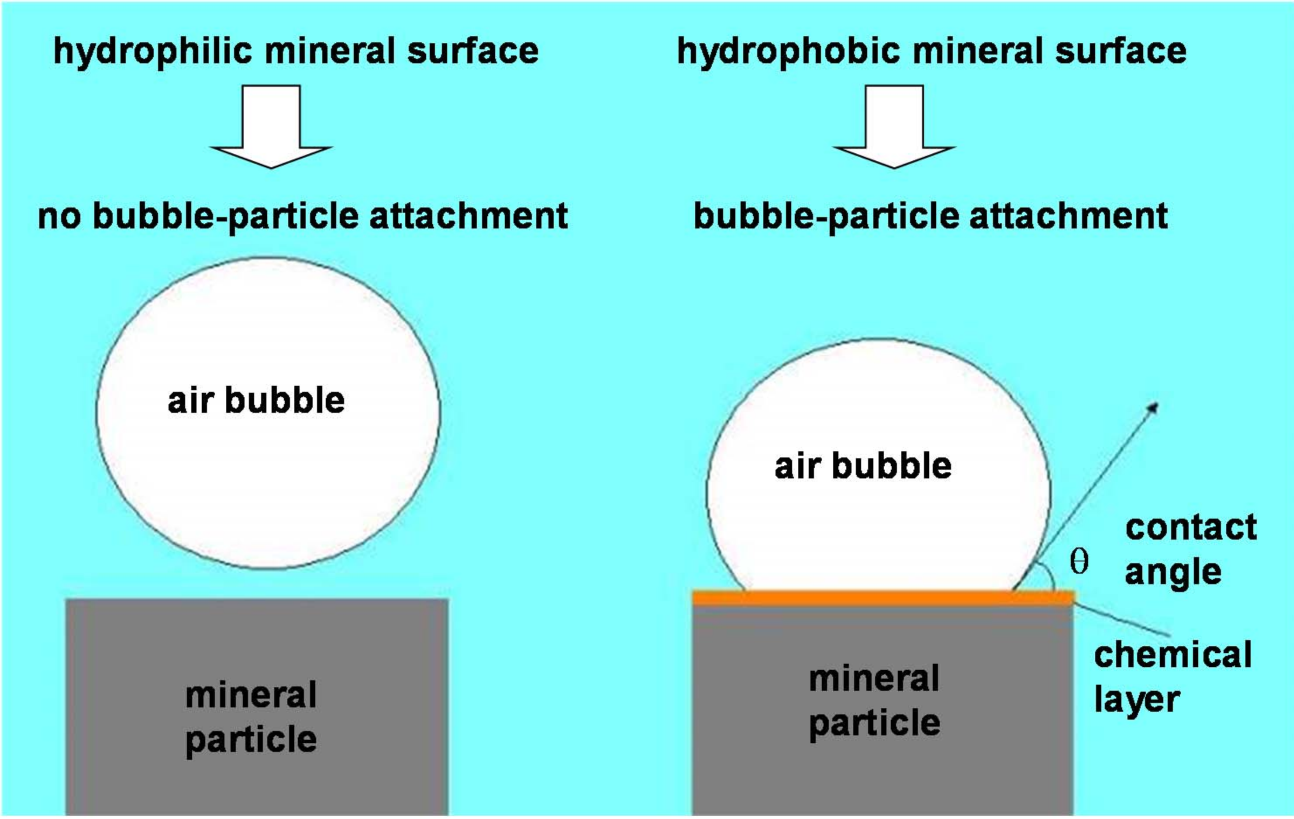
Flotation fundamentals

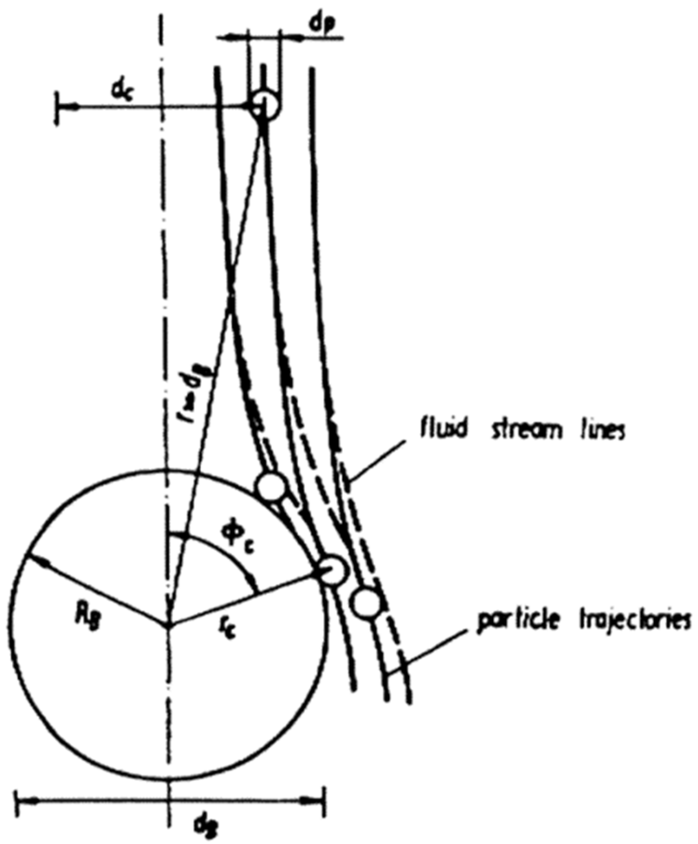
- Flotation is a separation technique
  - Separate fine grained minerals from others



Hydrophobic Surfaces



Attachment to bubbles



Gliding time:
- **Time between contact and attachment**

Engagement time:
- **Time required for the water film removal between particle and bubble**

Requirement for **attachment**
Gliding time > Engagement time

No attachment
Gliding time < Engagement time

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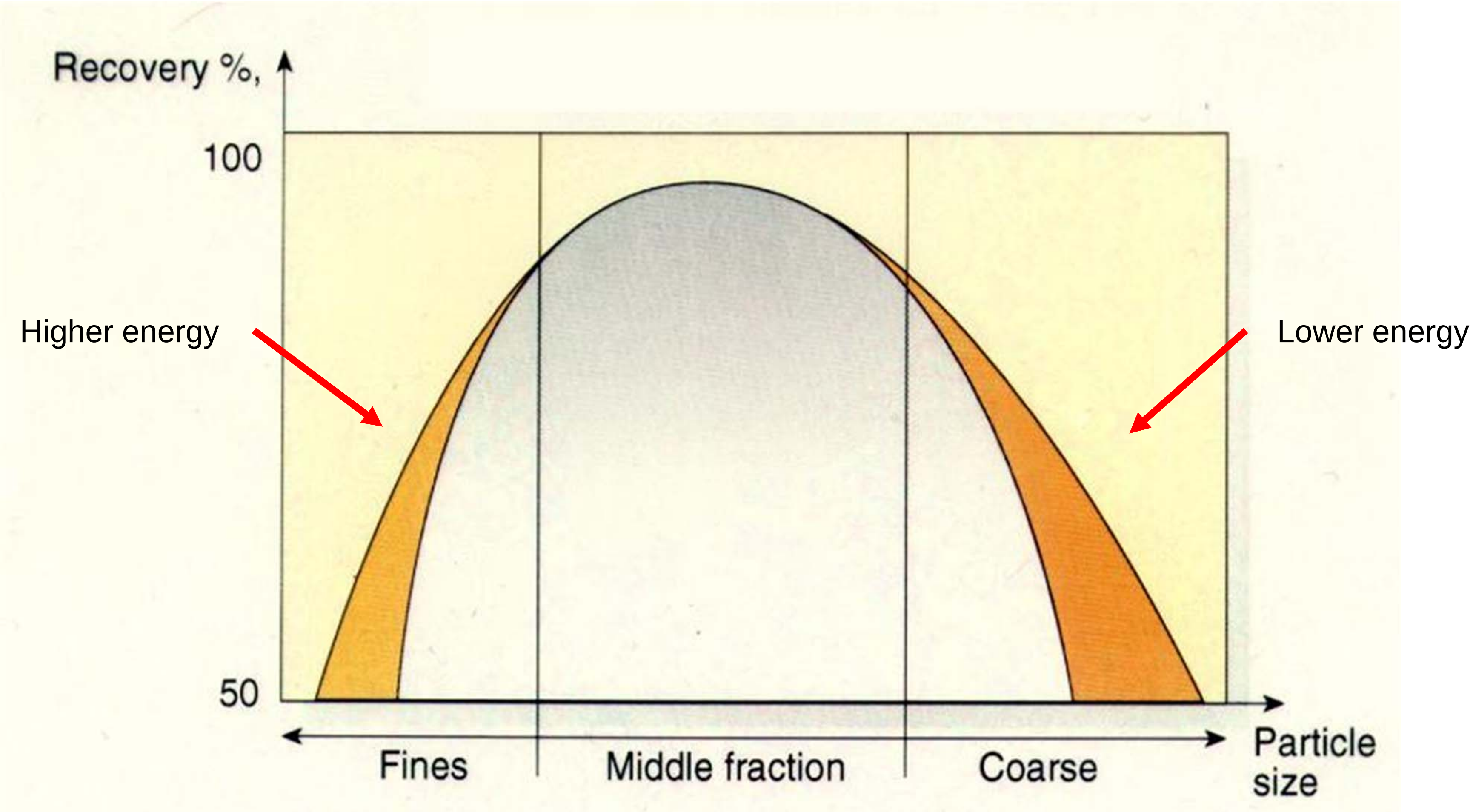
The Problem - Recovery by particle size



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Current approach in Industry - solutions

- Split Flotation
  - Successfully used in Nickel Flotation at Leinster (2 streams – Fine & Coarse), Mt Keith (3 streams) – Ultrafines, Fines & Coarse, Cannington Pb/Zn – Fines & Coarse

- Fine Grinding
  - Where liberation is a problem grinding finer is the only option to improve performance. This requires more power and is expensive. Once the particles are liberated then how do you optimise the recovery of the fine particles?

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Factors affecting Ultrafines Recovery

- Bubble Size
- Slurry pulp density and Rheology
- Mechanism selection & Energy used
- Froth removal from cell
- Flotation kinetics & Cell Design – cell volume, froth area and lip loading

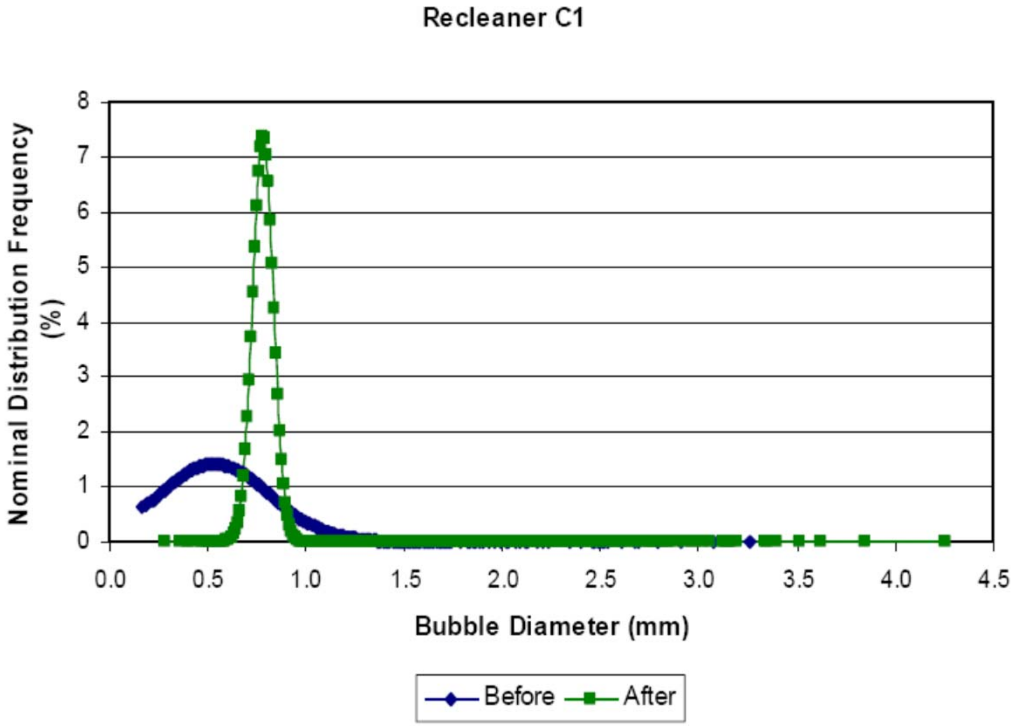
Bubble Size

- $S_b = (6 \times J_g) / d_{32}$

- If you can find a way to reduce bubble size then you can increase the S_b and hence recovery of fines can be improved. This is the principle behind the High Shear mechanism developed by Outotec. However, this is just one consideration.

Bubble Size

- Change in bubble size distribution using High Shear mechanism



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Slurry Pulp Density

- Full-scale test work at various sites has shown that the recovery of fine particles < 15 um are influenced by the pulp density.
- Reducing the pulp density from 25% solids down to 15% or less has shown a significant improvement in ultrafine particle recovery. This is primarily because the pulp viscosity has been decreased.
- The downside of this change is that you then require a significant increase in flotation cell volume so the size of the flotation plant will significantly increase.

Energy & Mechanism selection

- Testing in South Africa using high power mechanisms – 2- 3 kW/m3 has not shown a significant improvement in fines recovery at every site.
- Outotec have developed a High Shear mechanism where the energy input in between the Rotor & Stator is increased significantly.
- This is achieved by reconfiguring the Rotor & Stator mechanism to generate finer bubbles

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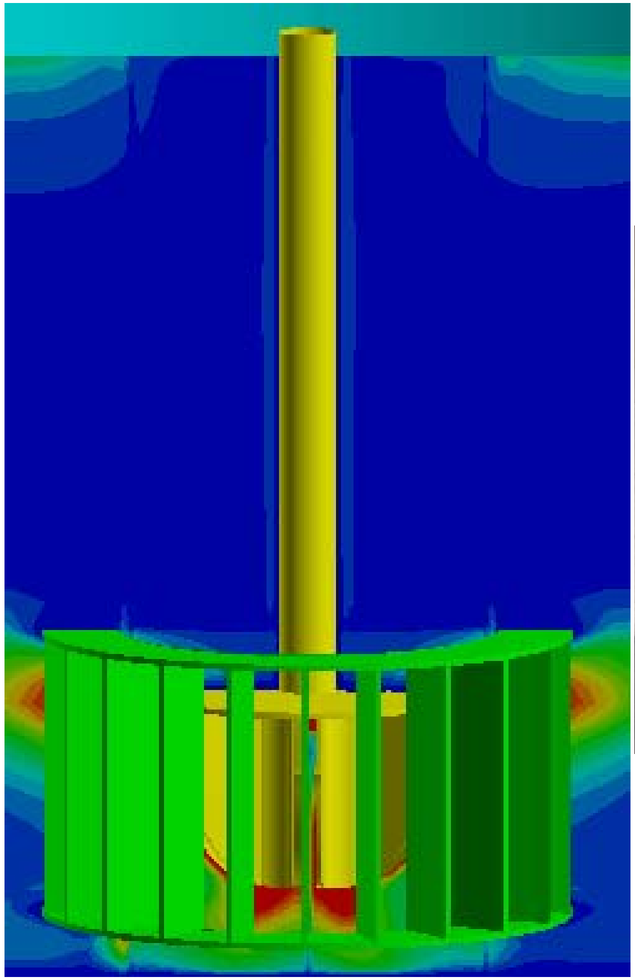
High Shear Stator



High Shear mechanisms were the most suitable technology available to reduce losses in fine size fractions

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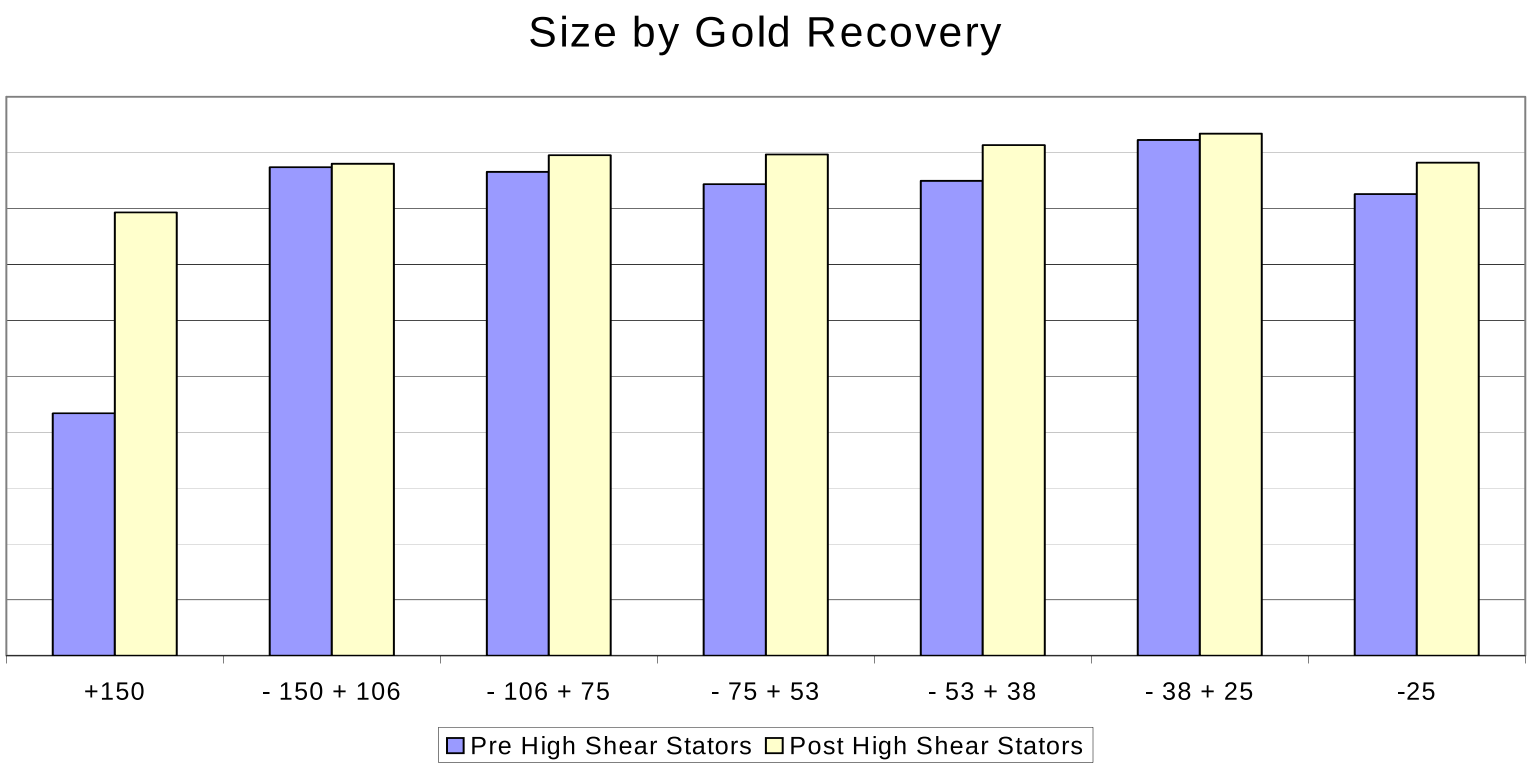
Case Study - Kanowna Belle



- Gold flotation recovery increase of 1.9%
- Plant gold recovery increase of 1.1%
- Flotation sulphur recovery of 5.4%

Other considerations - Froth Removal

- The Ultrafine froth is extremely stable and very difficult to remove from the cell. Hence, to be effective, Ultrafine cells require the following:

  - Large Launder Outlets to facilitate froth removal from the cell
  - Froth Carry rate should not exceed 1.0 – 1.2 t/m2/hr and Lip length should be maximised.
  - For conventional trough cells – 4 launders is mandatory
  - Froth washing can be beneficial so HG cells should be considered

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Flotation Kinetics

- Ultrafines (<15 um) have very slow flotation kinetics so to achieve a reasonable recovery long residence times (hours) are required in many cases.

- This then translates into the need for very large flotation volumes to maintain the residence time

- This leads to the requirement for very large volume flotation cells i.e. 200 – 630 m^3

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Sustainable use of
Earth's natural resources