SCALE-UP OF LABORATORY GRINDING AND FLOTATION TESTS FOR PLANT DESIGN AND OPTIMISATION

Brian Loveday
Laboratory tests provide a means for precise research and routine ore assessment.
How useful are these tests for prediction of plant performance and plant optimisation?
Scale-up of ball-milling

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- The forces in the laboratory mill are small.
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- The compression force required for complete breakage is $\alpha \ (\text{mass})^{0.66}$
  $\alpha \ (\text{diameter})^2 \ \alpha \ x$-sectional area
Lab. Data on dry grinding (Austin)

![Graph showing the specific rate of breakage $S_i$, Minute$^{-1}$ vs. particle size (mm) for different ball sizes (19 mm, 25 mm, 32 mm, 38 mm, 51 mm).]
Effect of ball size on number of contact points and forces
Observations on batch tests

- Addition of water has no effect (the theory of ball coating is speculation)
- Laboratory milling efficiency is adversely affected by high pulp viscosity
- Hence, use a relatively low solids concentration and measure power (torque) on all routine tests.
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- Equivalent kinetics for lean ores?
Comparison of bubble loading

- Batch cell (5L): Relative loading = 1
- Pilot-plant cell (50L) Rel. loading = 2,2
- Plant cell (50 m³) Rel. loading = 22

- Rate of flotation in the plant is about half that in a lab cell (Correction factor = 0,5)
Comparison of performance

![Graph showing performance comparison between Plant, Pilot plant, Corrected Batch data, and Batch Data. The x-axis represents Cum. Mass (%), and the y-axis represents Pt. Rec. (%).]
## Application of Models

**Kelsall Model (1961)**

<table>
<thead>
<tr>
<th></th>
<th>Non-Floating</th>
<th>Slow-Floating</th>
<th>Fast-Floating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass Fraction</strong></td>
<td>$a_0$</td>
<td>$a_1$</td>
<td>$a_2$</td>
</tr>
<tr>
<td><strong>Rate Constant</strong></td>
<td>0</td>
<td>$k_1$</td>
<td>$k_2$</td>
</tr>
</tbody>
</table>
Can we use batch data to model a plant, by applying corrections?

- Batch tests can be done on samples of feed, concentrate, tails, etc. and Nodal Analysis can be applied.
- This demonstrates that batch flotation rates are maintained – However it does not prove that the plant behaves in the same way.
Data from the Cominco Red Dog Lead Cleaning Circuit (Runge et al, 1997)

<table>
<thead>
<tr>
<th></th>
<th>Final Cleaner (Column)</th>
<th>Cl. Scav. (2 x OK38)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scale-up</td>
<td>Rel. to Pb</td>
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<tr>
<td>Galena</td>
<td>0.077</td>
<td>1</td>
</tr>
<tr>
<td>Sphalerite</td>
<td>0.053</td>
<td>0.68</td>
</tr>
<tr>
<td>Pyrite</td>
<td>0.039</td>
<td>0.51</td>
</tr>
<tr>
<td>N.S. Gangue</td>
<td>0.060</td>
<td>0.78</td>
</tr>
</tbody>
</table>
Observations on fitting batch data to a plant mass balance

- The Red Dog data showed that the separations achieved in the batch tests were significantly worse than the plant
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- The use of different scale-up factors for each mineral, allows the model to fit the base case mass balance (a force fit).
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- The Red Dog data showed that separations achieved in the batch tests were significantly worse than the plant.
- The use of different scale-up factors for each mineral, allows the model to fit the base case (a force fit).
- Prediction of the performance of a new circuit configuration would be difficult.
Is there another option??