Coalition for Eco-Efficient Comminution

Elizabeth Lewis-Gray, Chairman, CEEC
Presentation to SAIMM, February 2012
Vision

Accelerate **eco-efficient comminution** strategies through **promotion** of research, data and industry benefits
CEEC Activities

• International focus

• Website
  – Central data base
  – Easy access for technical and engineering staff

• Highlight issue to industry leaders through promotional activities
  – Present papers
  – Conferences
  – Magazine and online media articles

• Promote new comminution strategies

• Encourage discussion and debate
CEEC Medal

- Prestigious International Award
- Best technical paper presented or published in last twelve months
- Seeking nominations via website
- 15 March deadline
The opportunity: Comminution Energy Consumption

- 4% world electrical energy consumption
- 30 – 40% total mine

Source: DOE 1980, CSRP Eco-Efficient Liberation – Outcomes and Benefits 2003-2010
Comminution Energy Consumption

CO₂ contributions for the stages of copper concentrate production, Source: Norgate and Haque, 2010
Typical site comminution energy footprint

1999 Leinster Nickel Operations CO₂ Emissions

Source: Le Nause, Temos 1992
CEEC Sponsors
How should industry respond?

• Review and improve performance at **existing operations**
• Importantly, apply knowledge to **new circuit design**
Existing operations - Barrick

- Energy accounts for 25 – 30% of direct operating costs each year
- $200/oz
- Barrick has targeted improving energy efficiency by 8% through 2012
Identify opportunity, measure, analyse

Source: Buckingham, Dupont, Blain, Brits, JStieger. Improving Energy Efficiency in Barrick Grinding Circuits, ppt, SAG 2011
Cortez Mine - Grinding Improvements

<table>
<thead>
<tr>
<th>Specific Energy kWh/t</th>
<th>Baseline</th>
<th>Modify SAG liner profile</th>
<th>Curved pulp lifters</th>
<th>Cone crusher liner profile</th>
<th>Ball mill power reduction</th>
<th>Net Average kWh/t</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>5</td>
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- 0.5 kt CO₂
- 7.7 kt CO₂
- 3.7 kt CO₂
- 2.0 kt CO₂

ANNUAL GHG REDUCTION
SAG 2011 – Improving Energy in Barrick Grinding Circuits  
Buckingham et al
SAG 2011 – Improving Energy in Barrick Grinding Circuits  
Buckingham et al

**North Mara Mine - Grinding Improvements**

- Baseline: 22 kWh/t
- Improve feed fineness: 1.2 kt CO₂
- Improve pebble crusher: 0.6 kt CO₂
- Eliminate LCI as speed control: 0.7 kt CO₂
- Net Average kWh/t: 19 kWh/t

**Annual GHG Reduction**
SAG 2011 – Improving Energy in Barrick Grinding Circuits  Buckingham et al
Barrick’s areas of focus

- Analyse the grinding circuits for improvement opportunities
- Seek to optimize the throughput
- Feed crushing
- SAG mill operation including breakage functions and “pumping” capacities
- Pebble crushing
- Classification
- Ball milling

Source: Buckingham, Dupont, Blain, Brits, JStieger Improving Energy Efficiency in Barrick Grinding Circuits, ppt, SAG 2011
Barrick - Energy reduction and saving from three improvement events

- 60 million kWh annual savings = 216,000 GJ
  - 0.5% net efficiency improvement for Barrick global
  - Average improvement of 3.7% of the 3 mine sites’ total energy
  - Average of 8% improvement of the processor’s footprint

- Average improvement of 5.3% for 3 mine sites’ total energy.

- $5.2 million annual direct electrical savings
- $1.1 million potential future annual savings

Source: Buckingham et al
Greenfield plant opportunities

• Investigate new and more energy efficient technologies
• Coarser grind size
• More crushing less grinding
• New flow sheets and feed preparation
1. Improving & new technologies

• Fine crushing
  – VSI
  – HPGR
• Fine Screening
• Ore Sorting
• Gravity – continuous & batch
  – InLine Pressure Jig
  – Centrifugal Concentrators
• Coarse Flotation
2. Coarser grind size

Selection of the coarsest possible grind size

Source: Hukki RT, 1961
Energy Consumption increases with finer grinding

Source: Newcrest CEO Presentation, Feb 2012
Optimum liberation
Coarser grind may improve recovery
3. More crushing – less grinding

- Ball mills only apply 5% of energy used to particle size reduction
- Fine crushing is more energy efficient
- Energy more expensive
Castlemaine Goldfields plant
3 stage crushing, no grinding
4. Improved ore presentation and flow sheets

- Gangue Rejection
- Pre-concentration
- Blasting
  - Optimise fragmentation to maximise fines in ROM ore
  - “Bricks and mortar”
- Screening:
  - ahead of, and in, the grinding circuit
“The most efficient way to break rock, is not to break rock at all”

Dr Rob Morrison, JKMRC
Pirquitas – gangue rejection 2-12mm
The high potential of Witswaterand ore
Preconcentration using continuous gravity and flotation at coarse particle sizes

Yield Recovery Curve

Mineral characterisation test work that achieves recoveries in this zone are highly amenable to the Python processing system.
Key Benefits of new flow sheets

• Lower Capital Cost for Greenfields Installation
• Net reduction in energy consumption
• Increased gold recovery
• Increased gold production
• Reduced $/oz operating cost of gold produced
To balance global demand for energy and resources, eco-efficiency is essential.

Mike Daniel, CMD Consulting Pty Ltd.

Dr Andy Stradling, Teck Metals Ltd and Dr Zeljka Pokrajcic, CEEC Director

SAG2011 Vancouver Canada
The CEEC technical committee have selected a small number of papers available online that cover key comminution issues. Click the title of an article to download.

Journal Articles are peer reviewed

Technical papers have been copy edited and may have been peer reviewed prior to publication

Conference Papers: accepted by peer group for publication as part of conference papers

Presentations are not peer reviewed, have been presented at scientific meetings

Press articles: summary papers submitted for publication in print media

<table>
<thead>
<tr>
<th>Author</th>
<th>Date</th>
<th>Title</th>
<th>Paper type</th>
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<tbody>
<tr>
<td>Allen, M; Rosaguti, N; Innes, B; Stewat, M</td>
<td>2011</td>
<td>Energy Efficiency Assessments in Design-Seminal Decisions and Effective Processes</td>
<td>MetPlant2011</td>
</tr>
<tr>
<td>Bailey, C., Lane, G, Morrell, S and Staples, P</td>
<td>2009</td>
<td>What can go wrong in comminution circuit design?</td>
<td>Conference</td>
</tr>
<tr>
<td>Barns, K., Lane, G., Osten, K., &amp; Scagliotta, N.</td>
<td>2004</td>
<td>‘Benchmarking Energy Efficiency – A Case Study at the Macraes Gold Mine’,</td>
<td>Conference</td>
</tr>
<tr>
<td>Buckingham, L; Dupont J-F; Steiger, J; Blain, B; Brits, C.</td>
<td>2011</td>
<td>Improving Energy Efficiency in Barrick Grinding Circuits</td>
<td>SAG2011</td>
</tr>
<tr>
<td>Corder, G D; McLellan B C; Green S</td>
<td>2010</td>
<td>Incorporating sustainable development principles into minerals processing design and operation: SUSOP</td>
<td>Journal</td>
</tr>
<tr>
<td>Daniel, M.J.; Lane, G.; McLean, E.</td>
<td>2010</td>
<td>Efficiency, economics, energy and emissions _ Emerging criteria for comminution circuit decision making</td>
<td>Conference</td>
</tr>
<tr>
<td>David, D; Larson, M; Li, M</td>
<td>2011</td>
<td>Optimising Western Australia Magnetite Circuit Design</td>
<td>New Listing</td>
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Grinding Circuit Design Practices

I've been asked to describe the approach for grinding circuit design (what samples, what tests, nature of the output data, how best to use the data for sizing, flowsheet design, etc.). It's always easier to edit than to start anew with descriptions. Hence, I'm pulling together a short list of technical references (papers, parts of texts, etc.) to use as basis for discussion.

I'd be interested in hearing from others about how they would approach this description.

2 months ago

Jochen Franke • Hi Robert, presumably you are particularly interested in energy efficient grinding circuit design practices considering you have posted on the CEEC group. I can think of one paper by Malcolm Powell and A R Bye, Tenth Mill Operators’ Conference 2009. Adelaide, called Beyond Mine-to-Mill - Circuit Design for Energy Efficient Resource Utilization. It compares traditional vs innovative circuit design and potential for energy savings. Chris Bailey has also worked on this at JK amongst others.

If you are after general comments other than energy efficient circuits you may get a good response by posting on the LinkedIn group called : Grinding Mills Technology. This group now has over 1,000 grinding professionals joined up.

Hope this helps,
Jochen Franke
jochen.franke@scanalysce.com

2 months ago • Unlike
CEEC LinkedIn Discussions

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- Blasting techniques
- Comminution research
- Conference blogs
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