Is There Hope for Energy Efficiency in Comminution?

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Innovation as Defined by Peter Drucker in 1967 *

Innovation: purposeful and deliberate attempt to bring about, through technological means, a distinct change in the way man lives and in his environment – the economy, the society, the community, and so on.

[Technology] has become the battering ram which breaks through even the stoutest ramparts of tradition and habit.

...technological work is not done only for technological reasons but for the sake of a non-technological economic, social, or military end.

...the test of innovation is its impact on the way people live.

Technical Innovations of the Past 40 Years

- Diesel-powered, mechanized, mining equipment
- Grinding technology: SAG, Isa/Verti mills, HPGR
- Flotation cells: tank cells, column flotation and its cousins
- Bath smelting
- Pressure oxidation leaching of sulfides
- Leach-S/X-EW of copper
- Carbon in pulp for Au
- Automation
- Large
Technology Development: Moving Forward

• Have Big Thoughts about Small Things
• Work Together and Think Green
• Think L-o-o-o-n-g
SAG Mill – Ball Mill Circuit

- 62 concentrators in Canada
- 83% of ore processed in SAG/Ball Mill Circuits
- Energy hogs
  - 55,000 tpd gold mine consumes 38 MW of electricity for milling
- Ball Mill Energy Efficiency
  - 0.2% based on new surface created
  - 15-20% based on most efficient laboratory grinding
- Comminution consumes 2% of global electricity production
High Pressure Grinding Rolls

Energy Consumption: 30% less than SAG mills
Reduction ratio limited to 8:1
Multiple grinding stages and complicated material handling
CMIC-Canmet Mining Joint Project: Energy Recovery from SAG Mill – Ball Mill Circuits

Industrial Participants:
• Agnico Eagle
• Barrick
• Goldcorp
• Kingston Process Metallurgy
• Hatch
• McEwen Mining
• Metso
• Newgold
• Teck

Objectives:
• Identify potential means of energy recovery

Method:
• Energy balances around grinding circuits at Goldex, Canadian Malartic and New Afton mines
• Evaporation, heat loss, electrical/drive system, noise, vibration, slurry heating, grinding energy

Results
• 10% used for grinding
• 8% lost to drive system
• 5% transmitted to ambient air
• 77% reported to slurry of 18-38°C

Temperatures are too low for significant energy recovery
CMIC Process and Energy Group: New Comminution Technology Appraisal

Participants:
- Agnico Eagle
- Barrick
- Goldcorp
- Kingston Process Metallurgy
- Hatch
- McEwen Mining
- Metso
- Newgold
- Teck

Objective:
- Identify new energy-efficient comminution technology(ies) for collaborative development
- Target: 50% energy reduction

Dimensions:
- Undeveloped; no obvious fatal flaws; development will not occur naturally
- Good potential for energy saving & value generation
- Wide range of applications to milling
- Others not in commanding lead

Engineering Study by Hatch
- Literature & patent reviews
- Questionnaires to experts internationally
- In-house evaluations
- Identified five potential technologies

CMIC Evaluation
- Teleconference discussions with inventors
- Internal, collaborative evaluations
IMP Technologies Ltd. Crusher

- Ultra-fine dry crushing
  - Being developed in Australia
- Plenty of funds
- Lead blast furnace slag for cement
- 15 mm feed to 10-25 microns in single stage
- Being piloted at up to 1 tph feed
- CMIC actively communicating with IMP Tech

Single stage crushing of iron ore
The Conjugate Anvil Hammer Mill Concept

An invention of Larry Nordell, Conveyor Dynamics, Bellingham, Washington
Possible advantages:

- Larger reduction ratio than HPGR – less equipment, smaller footprint
- One-half energy consumption of HPGR

Status:

- Extensive DEM computer simulation
- No equipment built or tested yet
- Creation of inventor, academic, industrial consortium in discussion

1. Six-month study to check for fatal flaws and design prototype
2. Design and construct 1 m diameter 30 cm wide prototype
3. Conveyor Dynamics, UBC and CMIC member companies
4. Target start in Q3, 2016
Simulated Prototype Performance
Whither Technology Development in Mining

- Operations
- Technology
- Governance & Business Metrics

Sustainable Business
Questions?

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