Unlocking the potential of advanced high voltage pulse comminution

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HVP research at the SMI-JKMRC

• HVP (High Voltage Pulse) as an alternative comminution technology
  – Short pulsed energy – lightning
  – HVP applied to the mineral industry since 1970s
  – Better mineral liberation, but excessive energy consumption

• SMI-JKMRC started HVP research in 2007
  – Initial funding provided by ARC (AMSRI, LIEF)
  – Research sponsored by various mining companies
  – 7 HDR students (4 graduated)
  – Two HVP facilities installed
  – >20 papers published

‘Thunder is good, thunder is impressive; but it is lightning that does the work.’
— Mark Twain (1835-1910)
Improving ore processability by HVP

- **HVP selective breakage**
  - Ore pre-concentration
  - Waste rejection

- **HVP selective weakening**
  - Cracks/micro-cracks generation in mineralised particles
  - Reduced comminution energy consumption

- **HVP preferential liberation**
  - Hybrid processing method
  - Improved valuable mineral liberation and recovery

Potential to **TREAT & UNLOCK** Complex Orebodies!
Example: SAG mill pebble treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Ecs (kWh/t)</th>
<th>Yield (wt%)</th>
<th>Grade (Cu%)</th>
<th>Distr. (Cu%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broken</td>
<td>2.5</td>
<td>73.1</td>
<td>0.276</td>
<td>91.5</td>
</tr>
<tr>
<td>Unbroken</td>
<td>26.9</td>
<td>0.07</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.9</td>
<td>0.221</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Before treatment, 0.22 Cu%

Broken, 0.28 Cu%

Unbroken, 0.07 Cu%
HVP pre-concentration technology

Feed ore

HVP Selective Breakage

Screen

Low grade

High grade

(Zuo et al., 2015)

• Potential to discard 31% of the mass whilst losing only 10% of gold recovery.

(Huang et al., 2018)
HVP pre-weakening effect

• HVP damages the structure of mineralised particle
  – With 1-3 kWh/t
  – Detected by X-ray tomography & mercury porosimetry
  – Cracks/microcracks on the mineralised particle
• Pre-weakened fragments
  – Axb increases from 31 to 84 (easier to break)
  – Simulations indicate $19M/a saving in a 2000 t/h operation.
Coarse particle liberation and recovery

- HVP + mechanical grinding hybrid treatment
- Coarse liberation >106 mm
- Improved grade and recovery in flotation

(Parker et al., 2015)
Potential applications

• Waste rejection
  – Productivity
  – Haulage costs
  – Cracks/microcracks on the mineralised particle

• Selective processing routes based on grade
  – Energy saving
  – Improved grade and recovery

• Ore upgrade
  – Viable orebody cut-off grade

• SAG mill pebble treatment

• SAG feed treatment

“A potential Game-Changer!”

- CEEC 2017 Medal Selection Committee
Gaps for industrial uptake

• HVP parameters
  - The effects of HVP parameters on various HVP applications

• HVP generator system
  - HVP generation, power, efficiency, service life, insulation

• Scale-up
  - From batch lab testing to a small scale continuous system

• Circuit options
  - New opportunities for mining and processing circuit design

• Ore amenability
  - Variation in ore response to HVP treatment; Ore amenability characterisation.
Flexible HVP testing facility

- Newcrest Mining / UQ (SMI-JKMRC) sponsored facility
- Bespoke HVP unit from HUST
- Highly configurable & upgradeable
- HV: pulse transformer generator

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>Ability for batch and continuous processing</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>Ability to change different parameters that can influence energy efficiency i.e. pulse rising time</td>
</tr>
<tr>
<td>Processing Medium</td>
<td>Possibility to process in air or minimal water by changing process parameters</td>
</tr>
</tbody>
</table>
HVP Collaborative Research Program

SPONSORS
- Newcrest Mining
- Newmont Goldcorp
- Complex Orebodies Program

High Voltage Pulse CRP

Projects
- PhD1: HVP Parameter Study (Daniel Lay, co-supervised by HUST)
- PhD2: HVP Generator System (HUST, co-supervised by JKMRC)
- PhD3: Continuous Integrated HVP System (Flavio Andre, JKMRC)
- Short Project: Market and Literature Survey of HVP generator systems

RESEARCH PROVIDERS
- UQ (SMI-JKMRC)
- HUST

4yr Sponsorship

Expertise
Conclusion

- **Emerging opportunities**
  - HVP selective breakage combined with size-based separation for ore pre-concentration and waste rejection
  - HVP selective weakening for reduced comminution energy consumption
  - Hybrid HVP liberation for improved metal recovery

- **Unlocking the HVP potential**
  - Collaborative HVP research program
  - Pathways for industrial uptake
  - New technology to **TREAT & UNLOCK** complex orebodies for the mining industry