Best Maintenance Practices to Give Best Metallurgical Performance in Flotation

Ben Murphy, Technology Director - Flotation

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Today’s speaker

Ben Murphy  BE(Hon. Min. Proc.)  CP(Met)  MAusIMM

• 18 years in the mining industry

• Worked in base metal flotation concentrators in Indonesia, Ireland, South Africa and Australia in various metallurgical and managerial roles

• Joined Outotec in 2011 involved in design, equipment selection, commissioning and troubleshooting of flotation circuits

• Lives in Denver, Colorado
What does this training offer me?

Do you know what your optimum rotor wear life is?

Do we have a regular flotation equipment inspection schedule?

Is plant maintenance driven by metallurgical performance?

If you answered “NO” to any of these questions, you NEED to watch this…

For a better understanding of the impact that the condition of your flotation equipment can have on metallurgical results
Faulty level transducer

• Level arm sticking…..
  • Maintenance – Low priority as cell still working
  • Operations – would like fixed but one cell in bank, ‘we will make up recovery in others’
  • Metallurgy – too busy with accounting or in lab to look closely at level control trend…..

• Impact = poor control, loss of stability which generally leads to loss of recovery

• Rarely is loss due to substandard equipment condition quantified > perhaps if it was it would get more attention?
Importance of maintenance to metallurgy

- Equipment is designed to operate a certain way - production may suffer if it doesn’t
- Different groups on site (maintenance, operations, metallurgy) have different ways of looking at machines
- Need improved equipment monitoring and to quantify the impact of poor condition on production to justify changes
- Regular maintenance inspections and tracking equipment condition is a good start
Recap on requirements of a flotation machine and components
Quantifying the impact of maintenance
Flotation equipment inspections
Beyond the inspection
Best maintenance practices
Requirements of a flotation machine

- Slurry
- Air
- Bubbles
- Particles
- Froth
Importance of maintaining cell components
Why maintain flotation cells?

• Often hard to quantify cost / benefit due to time scale and resolution

• Examples Tilyard and Munro (2009)

  “Removal of tramp material from cells resulted in recovery change from 83-90%”

  “Replacement/repair of deteriorated mechanism and level control resulted in 4% recovery improvement and 2.5% grade improvement”

• Outotec is now spending time with clients to quantify and try to optimize their profitability and thus their maintenance strategy
Case Study: Quantifying mechanism wear

• Large copper concentrator with multiple rows of cells

• Entire row of cells had mechanism changed for comparison

• Second row used as control in each instance to account for variation

• Operating data taken for two weeks before and two weeks after each change
Case Study: Quantifying mechanism wear

- Changing mechanisms on row 1

<table>
<thead>
<tr>
<th></th>
<th>Row 1 copper recovery</th>
<th>Row 2 copper recovery (control)</th>
<th>Difference in copper recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Change</td>
<td>90.4 %</td>
<td>89.45 %</td>
<td>0.95 %</td>
</tr>
<tr>
<td>After 1 Changed</td>
<td>91.6 %</td>
<td>90.17 %</td>
<td>1.43 %</td>
</tr>
<tr>
<td>Recovery Difference</td>
<td>+1.2 %</td>
<td>+0.72 %</td>
<td>0.48 %</td>
</tr>
</tbody>
</table>

- Changing mechanisms on row 2

<table>
<thead>
<tr>
<th></th>
<th>Row 1 copper recovery (control)</th>
<th>Row 2 copper recovery</th>
<th>Difference in copper recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Change</td>
<td>92.66 %</td>
<td>91.33 %</td>
<td>1.33 %</td>
</tr>
<tr>
<td>After 2 Changed</td>
<td>91.76 %</td>
<td>91.41 %</td>
<td>0.35 %</td>
</tr>
<tr>
<td>Recovery Difference</td>
<td>-0.9 %</td>
<td>+0.08 %</td>
<td>0.98 %</td>
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The maintenance inspection

• Easiest way to track equipment condition

• Integral part of equipment management

• Many sites still don’t have regular inspection programs

• Equipment suppliers great source of information on what to look for
What to look for: External Inspections

<table>
<thead>
<tr>
<th>General Tank and Walkways</th>
<th>Drive Mechanism</th>
<th>Instrumentation and Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface protection</td>
<td>Bearing bolts tight</td>
<td>Pinch valves intact</td>
</tr>
<tr>
<td>Floor grating complete</td>
<td>Greasing plates fitted and readable</td>
<td>Pinch valve guides and hinges</td>
</tr>
<tr>
<td>Handrails intact</td>
<td>Bearing noise/heat</td>
<td>Air leaks from instrument lines</td>
</tr>
<tr>
<td>Tank hold-down bolts tight</td>
<td>Air leaks (bearing assembly)</td>
<td>Level transmitter movement</td>
</tr>
<tr>
<td></td>
<td>Noise/vibration</td>
<td>Level float clean</td>
</tr>
<tr>
<td></td>
<td>Pulley guard fitted and secured</td>
<td>Damage to instruments</td>
</tr>
<tr>
<td></td>
<td>Motor noise/heat</td>
<td>Condition of wiring</td>
</tr>
</tbody>
</table>
Example: Belt Drive Issues

• Tension and alignment are shutdown jobs > at a minimum needs to be stopped and isolated.

• Symptoms
  • Noises coming from belt area
  • Drive rack or bridge vibration / wobble
  • Motor noises
  • Heat

• Don’t just walk past, report and action follow-up inspection
Example: Level Indicator

- Typical Issues
  - Shaft sticking
  - Ball sinking (or floating on froth)
  - Not set-up properly
  - Reading incorrectly
    - Not calibrated
    - Not spanned correctly
    - Need to check regularly

- Is level control OK?
  - Loops tuned
  - Valve positioners working?
  - Perhaps it’s the level indicator?
## What to look for: Shutdown Inspections

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<tr>
<th>General Tank</th>
<th>Drive Mechanism</th>
<th>Instrumentation and Control</th>
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<tbody>
<tr>
<td>Launder and crowding support</td>
<td>Pulley wear</td>
<td>Dart valve alignment and seating</td>
</tr>
<tr>
<td>Surface protection</td>
<td>Pulley alignment</td>
<td>Condition of dart valves and seat</td>
</tr>
<tr>
<td>Bolt condition (erosion)</td>
<td>Belt tensioning</td>
<td>Condition of dart rods and guides</td>
</tr>
<tr>
<td>Bolt coverage</td>
<td>Belt wear</td>
<td>Wear on pinch valve sleeve</td>
</tr>
<tr>
<td>Foreign objects present</td>
<td>Lower shaft condition</td>
<td>Pinch valve sleeve position</td>
</tr>
<tr>
<td>Launder lips level and clean</td>
<td>Rotor wear</td>
<td>Level float cleaning</td>
</tr>
<tr>
<td></td>
<td>Rotor blockage</td>
<td>Positioning of airflow meter</td>
</tr>
<tr>
<td></td>
<td>Stator wear (vanes all present)</td>
<td>Check operation of positioners</td>
</tr>
<tr>
<td></td>
<td>Check for debris lodged in mech.</td>
<td>Check parameters and span</td>
</tr>
<tr>
<td></td>
<td>Bolt condition and coverage</td>
<td></td>
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</tbody>
</table>
Example: Mechanism Inspection

- Primarily looking for wear
  - Lining thickness
  - Tearing
  - Exposed skeleton
  - Deformation

- Blocking of air and mixing slots

- Is it being reversed regularly?
Example: Dart Valves

Guide block wear

Dart plug wear

Positioned condition
Beyond the inspection

• Inspections, though good, are reactive

• Storing the history from inspections in MMS moves to predictive

• Modern mines collect a vast amount of process and equipment data

• Can we use this data to predict when change out is required?
Case Study: Time-in-State-Analysis

• Time-in-state (TIS) metric is an index value which describes equipment performance against a pre-defined benchmark

• Technique uses plant data to enhance maintenance decision making

• Case Study African nickel concentrator

• Maintenance performed on cell in early July 2013 (included mechanism and valve replacement)

• Post maintenance action a >7% increase in recovery was observed
Case Study: Time-in-State-Analysis

- From analytical phase ‘in-state’ metric defined and benchmark (upper limit) set.
- If metric goes above performance limit and stays there maintenance action required.
- It can be clearly seen before and after maintenance action taken
- Since method implemented no unplanned breakdowns in float circuit
Maintenance best practice

• Adopt modern maintenance practices to suit larger equipment

• Improvements in safety and efficiency

FloatForce 650
Weight ~110lb

FloatForce 2200
Weight ~ 4,700lb
Maintenance best practice

- Understand components and their roles
- Routine instrument calibration and control loop tuning
- Metallurgists get involved
- Regular inspections
- Maintain MMS (with component history)
- Quantify impact of wear and/or maintenance actions
- Clear job procedures and detailed work methods
Summary

• Equipment condition is critical to flotation plant performance

• Though reactive, plant inspections are a good way to monitor condition

• Quantifying the cost of poor equipment condition should be done more often

• Potential exists to improve plant profitability by improving maintenance practices
References / further reading


Webinar’s to come

Mark your calendar and register in www.outotec.com/webinars

<table>
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<tr>
<th>Date</th>
<th>Topic</th>
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<tr>
<td>July 8</td>
<td>Boosting flotation productivity with modern technology – modernization and upgrade opportunities</td>
</tr>
<tr>
<td>August 5</td>
<td>Stabilization versus optimization – insights to flotation process control</td>
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Recording available online www.outotec.com/webinars:
- Finding and eliminating bottlenecks in flotation plants
- Optimizing froth area of the flotation cell
Contact us

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