Condition monitoring for process control
**Overview of future Neles**

**Neles**

<table>
<thead>
<tr>
<th>Products</th>
<th>Industries</th>
<th>Company</th>
</tr>
</thead>
</table>
| Control valve solutions | Leading position as flow control solution and services provider serving customers in oil & gas, petrochemicals, pulp, paper and bio industry and other process industries | Olli Isotalo  
CEO  
Vantaa, Finland  
Headquarters |
| On-off valve solutions | ~2,900 Employees | ~40 Countries present  
~40 Service Centers |
| Intelligent safety valves | Valve Controllers, Actuators & Limit Switches | Valve services and spare parts |

The partial demerger is targeted to be completed in the second quarter of 2020, subject to the receipt of all required regulatory and other approvals. The Extraordinary General Meetings of both Metso and Outotec approved the transaction on October 29, 2019.
The most modern valve plant footprint globally

- Shrewsbury, MA, USA: Jamesbury® valves
- Fergus Falls, MN, USA: Valve monitoring applications
- Sorocaba, Brazil: Service and supply center
- Horgau, Germany: High performance Neles® butterfly valves
- Helsinki, Finland: Specialized in Neles® engineered valves and intelligent positioners
- Dombivli and Ambernath, India: Jamesbury® EasyFlow valves and Neles® Scotch Yoke actuators manufacturing for India and global markets
- Vadodara, India: Service and supply center
- Chungju, South Korea: Neles® globe valves, Services
- Shanghai, China: Regional service Standard Neles® and Jamesbury® product manufacturing globally
- Jiaxing, China: A new valve hub ready 2020

40 service centers globally
Existing performance
Stable - Reliable - Optimal
Demonstration of finding plant problems
Results- $$ Benefits
Benchmark – how do you rank?
Questions and answers
Condition monitoring for optimal control performance

- Sites with no control performance program
  - 1.5M to 5.3M in under utilized assets by running in manual in a 1000 loop site
  - Are you repairing the correct valves?
  - 30% of control loops are tuned incorrectly, increasing variability in the process.
  - A tremendous amount of money can be saved by understanding the control loop interactions and implementing corrective action.

10%-35% of control loops are in **manual**

30% of control valves need maintenance
## Detected issues

### Benchmarking

<table>
<thead>
<tr>
<th></th>
<th>Plant 1 – 1100 valves</th>
<th>Plant 2 – 390 valves</th>
<th>Typical</th>
<th>World class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive valve travel</td>
<td>4 %</td>
<td>9 %</td>
<td>5 – 15 %</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>Stiction</td>
<td>4 %</td>
<td>6 %</td>
<td>5 – 10 %</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>Oversized</td>
<td>20 %</td>
<td>12 %</td>
<td>5 – 15 %</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>Undersized</td>
<td>6 %</td>
<td>4 %</td>
<td>5 – 10 %</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>Loops in manual mode</td>
<td>21 %</td>
<td>12 %</td>
<td>10 – 25 %</td>
<td>&lt; 10%</td>
</tr>
</tbody>
</table>
Existing Control performance

SENSOR
- Sensor Fail
- Oscillation
- Excessive Noise

Flow
Pressure
Temperature
Composition

CONTROLLERS
- Configuration Errors
- Manipulated Variable
- Tuning
- Valve Stiction
- Hysteresis
- Valve Sizing

ExperTune's PlantTriage software paired with Metso's Control Performance Solutions provide an intelligent key to plant optimization.

INDUSTRIAL PROCESS
- Design Errors
- Interactions
- Constraints
- Action

Feedback
- Non-Linearity
- Disturbances

Poor Dynamics
Improve Reliability
Monitor the control infrastructure

Valves & Positioners
- Valve travel & reversals
- Stiction
- Oscillation

Sensor measurements
- Noise
- Flatline
- Off scale
- Spiking

Identify performance issues before they cause an incident

<table>
<thead>
<tr>
<th>Loop</th>
<th>Description</th>
<th>Sensor health %</th>
<th>Sensor Spiking %</th>
<th>Noise Band %</th>
<th>Noise Band %</th>
<th>PV Availability %</th>
<th>PV Alert %</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC01P</td>
<td>Hold Tank</td>
<td>80%</td>
<td>20%</td>
<td>40%</td>
<td>1%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TC02M</td>
<td>Product Temperature</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TC03M</td>
<td>Temperature</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TC04M</td>
<td>Pressure</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TC05M</td>
<td>Flow</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TC06M</td>
<td>Level</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TC07M</td>
<td>Waste Fluid</td>
<td>70%</td>
<td>5%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TC08M</td>
<td>Steam</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>TC09M</td>
<td>Feed</td>
<td>70%</td>
<td>15%</td>
<td>5%</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

metso
## Maintenance approach

<table>
<thead>
<tr>
<th>Maintenance approach</th>
<th>Cost impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive maintenance or repair</td>
<td>High operating and maintenance costs 5 money symbols</td>
</tr>
<tr>
<td>Race to failure and repair</td>
<td></td>
</tr>
<tr>
<td>Preventive or time-based maintenance</td>
<td>High operating and maintenance cost and higher frequency of unplanned downtime 5 money symbols</td>
</tr>
<tr>
<td>Service at a fixed cycle or time interval</td>
<td></td>
</tr>
<tr>
<td>Condition-based monitoring with single variable</td>
<td>Moderate operations and maintenance cost, high frequency of false positive diagnosis 5 money symbols</td>
</tr>
<tr>
<td>Monitors process data, identifies bad trends and alerts before failure</td>
<td></td>
</tr>
<tr>
<td>Predictive and prescriptive maintenance analysis</td>
<td>Minimal operations and maintenance costs and downtime approach zero 2 money symbols</td>
</tr>
<tr>
<td>Analysis with multivariable time series data</td>
<td></td>
</tr>
</tbody>
</table>

Manage the improvement workflow

Select KPI’s

Establish thresholds for performance
   Not set at point of failure

Apply an economic weight factor per loop
   Aids in prioritizing issues

Monitor
   Review reports regularly (subscribe)
   Set alerts to specific conditions
   Evaluate condition trend direction and change rate

Act!
Focus on reliability
Pay attention to hardware KPIs

Is the Hardware performing?

Hardware

Sensor Health
- Flat-Line
- Noisy
- Spiking

Valve Health
- Sizing
- Stiction
- Hysteresis
Improve Control
Can the controller do the job?

At a limit

- The control valve is 100% open/closed
- The variable-speed drive is at min/max speed
- The heater is on (or off) 100% of the time
- The control output is limited by a soft limit
- The process variable is at 0% or 100% of its span

Controller in manual (open loop)

- Control element only moves with operator intervention
- No response to disturbances

Stability is affected when you cannot respond

<table>
<thead>
<tr>
<th>Loop</th>
<th>Description#</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>11FFC615</td>
<td>Raffinate to WS</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>C05TC023</td>
<td>V-17 tank temp</td>
<td>43.25</td>
<td>98.77</td>
<td>100</td>
</tr>
<tr>
<td>C04TC039</td>
<td>Sweep gas flow</td>
<td>0</td>
<td>87.18</td>
<td>100</td>
</tr>
</tbody>
</table>
What to do

Relieve the constraint
- Valve too small/large resize / alternate trim
- Change pumps
- Reduce throughput
- Repair / re-range measurement device

Find out why controller is manual
- Repair hardware
- Re-design the loop

Find the cycling loops, identify new robust tuning values
Choose KPIs at higher levels
Drill down to other assessments to determine specific actions

Is the Controller controlling?

Service factor

At limit
Valve at Limits
PV at Limits

Controlling
In Normal Mode
Optimize Control
Analyze performance

Interacting Controls
Closed control loops that disturb other loops
Create cycles

Poor Controller Tuning
Too aggressive, too slow
Overshoot
Cycling

Reduce variability through better control
Manage performance

Find root causes
Correlate oscillating loops
Check interactions

Tune controllers to meet objectives
Responsive and robust throughout the operating envelop.
De-couple with appropriate parameters

Find the cycling loops, identify new robust tuning values
Drive variability reductions

Is the Control effective?

Control Measures

Variability
- Statistics

Control
- Error
- Harris Index

Oscillations
- Significance
- Period
Optimize

Determine best operating point(s)

Operate closer to targets
   Once stable, move the average

Keep key variables on their targets
What to do

Once stable move setpoints closer to targets

Use 6-sigma to identify opportunity gaps

Compute and report savings associated with closing the gap

Monitor
  Review reports regularly (subscribe)
  Set alerts on Time of Spec, opportunity gap

Largest benefits are obtained by moving the operating points
Expertune PlantTriage
Demonstration
Valve analysis

**Problem**
- Valve oscillation detected by PlantTriage
- Device demonstrated big deviation and pressure jumps
- Leakage revealed in the actuator diaphragm

**Solution**
- Automatic detection
- Actuator and valve were replaced in the next planned shutdown
- The quick flow changes disappeared
Unplanned shutdown avoidance

Valve monitoring

**Problem**
- Excessive oscillation due to valve
- Field inspection revealed the actuator was barely bolted in.

**Solution**
- Automated detection
- Replace and ensure all four bolts secure with an addition of an adhesive
Control loop analysis

European Oil refinery

Problem

Valve has known to have previous issues
Valve demonstrating a lot of movement
Valve monitored and found to operate well

Solution

Adjustment to the positioner performance level
Control loop was retuned
No additional repair to the valve package
Valve lifetime extended
Case studies

Bleaching plant in Russia
Saves 400 KEUR a year

BP’s refineries
Estimate $1-5 million per refinery, per year.

European refinery
Saves 7 MEUR per year

Vale Brazil
A 100% Return on Investment in 4 months

SABIC
Saves $1 million per year

Ras Gas
Saves $1 million per year
Summary
Utilize condition monitoring:

01 Implement **predictive maintenance**

02 **Activate** existing controllers

03 **Optimize** performance
Resources and examples

Visit Metso.com, search for Expertune to discover more
For further information

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