MET FLOTATION SOLUTION

SGS’ advanced systems expertise can help you to be more successful by developing and implementing technology-enabled solutions. Our proven project methodology seeks to extract best operating practices from your personnel, program it for automatic decision making and combine it with our in-house expertise. The resulting body of knowledge is then coded and deployed using our proven software platform, MET. Our approach brings understanding, consensus and a sense of ownership as the deployed solution demonstrates positive results.

MET FLOTATION SOLUTION

Flotation circuits are considered among the most diverse and challenging circuits to optimize. Although acceptable performance is not difficult to achieve, maintaining acceptable performance and/or obtaining a greater performance is challenging. Many factors influence the performance of a flotation circuit including:
- Process disturbances (flow, particle size) from grinding.
- Instability of flotation levels and recycle streams.
- Changes in feed mineralogy or grade resulting in fluctuating yield and recoveries.

Without a thorough understanding and timely response to changing conditions, stabilization and optimization of a flotation circuit cannot be easily achieved.

SGS offers the MET (Modular Expert Technology) Platform, which consists of a set of tools that support the easy and rapid development, commissioning and tuning of expert systems and advanced control applications.

The MET Flotation Solution is specifically designed for the stabilization and optimization of flotation circuits. It integrates into the overall control hierarchy by utilizing and enhancing the regulatory control layer to optimize operational performance.

BENEFITS

The overall benefits of the MET Flotation Solution include:
- Increased throughput and improved circuit stability
- Consistent operations and decision making across operating shifts
- Improved overall process performance, reliability and quality through process stabilization and optimization
- Improved circuit stability (cell levels and mass pull) minimizing the negative effect of process disturbances
- Minimized tailings grade
- Improved recovery while maintaining required concentrate grade
- Minimized production costs through optimal use of manipulated variables.
- 24x7 operation with online process tuning requiring no downtime
- Short payback periods

TECHNICAL FEATURES

The objective of the MET Flotation Solution is to stabilize the mass-pull and subsequently, optimize the recovery through a better control of the concentrate grade. This solution is implemented through the combination of the MET platform and the METcam system for froth visual characterization. Expert systems capture operator and process engineering knowledge in a rules database so as to continually and constantly optimize the process operation. The MET Flotation Solution makes changes to control loop set-points, as a response to the changing process conditions. This solution is augmented with advanced modules including multivariable and image-based process control.

LEVEL STABILIZATION

Disturbances (mainly an effect of load changes, equipment startups and shutdowns) manifest at the levels of the flotation cells and are propagated...
throughout the entire flotation cell train unless they are properly controlled. This affects the stability and performance of the entire flotation circuit, and is associated to economic losses and even environmental effects.

**MET-Flotation-Stabilizer** is a multivariable (MIMO) control strategy designed to control the levels in a flotation circuit. It continually monitors the circuit and, at every valve movement, it takes into account the valve action and levels of the entire train of cells. It intelligently makes a decision on how to act so as to reject disturbance propagation through the train. Consider a train of \( n \) flotation cells in series, where the outflow of each tank is entering the following tank below the liquid level.

When using a PID-type control strategy, it is impossible to tightly control all the levels in a train because the interactions among cells are not taken into account. Consequently the control loops are detuned in practice, leading to intentional sluggish control and poor performance of the circuit. This would also lead to disturbance propagation in the train as illustrated by Figure 2

If one attempts to tune the PIDs more tightly to reject this disturbance, the process will become oscillatory or even unstable. The MET-Flotation-Stabilizer is therefore a multivariable control strategy that is designed for:

- Tighter set-point tracking.
- Rejection of load disturbances.
- Reduced interactions.
- Disturbance rejection between cells.

This allows for a more stable circuit which results in grade and recovery improvement. This also has advantages to downstream process (e.g. steady feed to cleaners).

### MASS PULL OPTIMISATION

Figure 3 shows how the control layers interact for a flotation process that implements both regulatory (MET-FS, Float Stabilization) and optimizing control. The first aim is to stabilize the levels around setpoints, then the setpoints can effectively be changed to optimize the circuit, as is explained by the diagram. Once stabilization is achieved, it is possible to change the setpoints. Not only can the mass pull be increased to run closer to the limits (as above), smaller setpoint changes can be made more often to minimize overshoot and ensure effective supervisory control.

### FROTH VELOCITY AND MASS PULL CONTROL

Along with the SGS METCam solution, the MET Flotation expert system optimizes flotation circuits. Figure 4 explains the flow of control signals between the MET-Flotation-Expert and the plant. Bubble characteristic measurements and froth velocities (related to the mass-pull) are sent to the expert system where it is compared to a setpoint. The expert system then manipulates the air, level and wash-water (in the case of a column) setpoints to ensure a constant and stable mass-pull.

### GRADE AND RECOVERY OPTIMIZATION

Once stabilization is achieved, optimization strategy can now move these setpoints in the following fashion:

- Increase the mass-pull to continuously increase the recovery when the concentrate grade is not constrained.
- Decrease the pull when the grade drops below the target.
- Apply an adapted strategy to ensure effective operation within other plant constraints such as conditioner / sump level. Changes are made to keep within other process constraints such as sump levels, circuit capacity and selectivity of metals.

The logic may give priority to changing one MV above the other, and may also exhaust one before manipulating the others. For example, the air setpoint is first increased to the maximum before
adjusting the pulp level. This is adaptable to site requirements. Furthermore, different strategies may be implemented for rougher circuits (where the general aim is to increase recovery) as opposed to cleaner circuits (where the aim is to ensure the concentrate grade meets the target). In some circuits, it is also imperative to ensure that there is a diminishing froth-velocity-profile down the bank to ensure that more of the faster floating material is recovered first (in the first few cells) without too much of the slower floating material being entrained (in the last few cells). However, an overall strategy is used to ensure that the circuit is considered as a whole.
FROTH VELOCITY MULTI PROFILER SELECTOR

The Froth Velocity Multi Profiler Selector is an add-on that allows for a multivariable control strategy based on selecting a froth velocity profile from a pre-configured set of profiles (maximum and minimum for each cell). This selection can be done by the operator or automatically by the expert system. To achieve the objectives of the selected profile, the expert system controls variables such as cell level and air flow.

TECHNICAL ACHIEVEMENT

The MET Flotation Solution has been successfully implemented at numerous sites across the world. It has proven itself to be a valuable tool in achieving improved production throughput and operational stability.

This can best be illustrated by actual operational results on the rougher circuit of a copper concentrator (Table 1). In this case, the following improvements were produced in both the rougher and final concentrate grade and recovery, over a period of approximately two months.

This improvement in the rougher recovery of the fast floating material also facilitated the improvement of the final grade of the entire circuit. This was brought about by the ability of the expert system to maintain a diminishing velocity profile down the bank – as opposed to operator control.

MET SOLUTION APPROACH

The successful completion of a control system implementation rests on the effective integration of three essential core capabilities:

- Mineral processing.
- Process control.
- Project management expertise.

The standard approach taken during a grinding system implementation depends on the achievement of the following long term objectives:

- Ensuring that initial system benefits are achieved and then utilised for continued performance gain
- Long term site acceptance and ownership of the system

The success of any advanced control system lies in the continued utilization of the system, which is primarily a function of its overall acceptance by the end users. Long term acceptance can only be achieved by ensuring that the users and the personnel maintaining the system feel ownership of it.

SGS’ approach to project integration is an operations-centric approach, where the key to success lies in the inclusion of production and technical personnel during all stages of the project, thus contributing to the long term success of the application.

The MET Grinding Solution is developed using the MET platform, a development environment which allows for the creation and deployment of real-time, mission-critical expert solutions. The MET platform consists of a set of tools to support the easy and rapid development, commissioning and tuning of expert systems and advanced control applications interfaced with external systems including DCSs, PLCs, and databases.

Key features include:

- Open/graphical logical structure using logic containers where the overall control strategy and logic are open and easy to understand by the end user and modifications to logic is easily implemented
- Powerful presentation of schematics, control logic, animation of logic blocks, data connections, and graphical features such as graphs, charts, tables, alarm queues

Table 1

<table>
<thead>
<tr>
<th></th>
<th>START DATE</th>
<th>END DATE</th>
<th>ROUGHER-CONC GRADE</th>
<th>FINAL-CONC GRADE</th>
<th>RECOVERY</th>
<th>TAILS</th>
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<tbody>
<tr>
<td>ON</td>
<td>2011/10/28</td>
<td>2011/12/29</td>
<td>6.07</td>
<td>23.1</td>
<td>80.0</td>
<td>0.161</td>
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<td>OFF</td>
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<td>2012/01/04</td>
<td>5.98</td>
<td>22.7</td>
<td>79.3</td>
<td>0.165</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Statistically Significant Improvement</td>
<td>0.09%</td>
<td>0.43%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>
• A wide collection of process object, data processing, and development support libraries. Real-time modification where new logic can be added and implemented online, without recompilation or shutdown.

• Data recording where data can be recorded with a predetermined interval and later used for plant analysis and surveys.

• Data replay where it is also possible to record real-time data (OPC variables) and later play it back.

• Reliable data communications including redundancy, diagnostics and monitoring.

• Innovative custom solutions based on expert systems technology.

MET SUPPORT

SGS offers the most complete support service for our applications to ensure maximum long term returns from your expert system application. The support subscriptions combine on-site and remote assistance according your specific needs. The SGS support service assures your company that the value added through the implementation of the SGS expert system will be consolidated and enhanced over the years.

With over 11 years of demonstrated results, SGS has more installed and operating expert systems than any other company in the world. Contact us today to find out how our advanced process control solutions can provide you with the decision making tools to streamline your production in real time.

CONTACT INFORMATION

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