Wet Flue Gas Desulphurization (FGD) Optimization

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Outline

• Review of Wet FGD
• FGD Optimization
• Results
• Benefits
Power Plant Optimization Systems

- NOx Control
  - SCR Systems
  - SCONOx

- Burner Systems
  - LNCFS
  - TFS 2000™
  - Fuel Switching

- Boiler

- Ash Handling

- Pulverizer

- Particulate Control
  - Fabric Filter
  - Electrostatic Precipitator

- Flue Gas Desulfurization
  - Wet FGD
  - Dry FGD
  - FDA

- Substation Systems

- Steam Turbine and Generator
SO_2 + CaCO_3 + \frac{1}{2}O_2 + H_2O \rightarrow CaSO_4\cdot2H_2O + CO_2
Power Perfecter™ Implementation

DCS and Historian

Pegasus Data Interface

Global Optimizer

Optimizer Controller Scheduler

APC MVC Controller

Auto-Retune

Real-Time Feedback

Workstation
MPC Functionality

- **Advanced Process Controller:** Used to reduce variability on a high frequency (minute by minute or faster) basis due to external factors, thus, driving the manipulated variables to optimal settings.
Model Predictive Control

- Use first step of horizon
- MV measured value
- MV set point
- Perfecter optimizes future trajectories using an internal simulation
- CV measured value
- CV desired value
- current time indicator
- CV prediction
- MV prediction
Power Perfecter™ Advantages

- Reduced Variability
  - By Moving the Manipulated Variables at the right time and right amount so that CV’s stay close to their setpoints

- Optimal Allocations of the resources (MV), to achieve better objective
  - Calculating the optimal combination among Manipulated Variables trajectories for minimizing the overall cost function
Power Perfecter™ Advantage – Reduced Variability

- Reduced maintenance
- Safe operation
- Increased efficiency

Example: Steam Temperature and Pressure Control
50% Reduction in Variability is Typical
Power Perfecter™ Advantage
Optimal Resource Allocations

### Diagram Description

**Power Perfecter**

- **Steady State Models and Optimizer**
  - Outputs Targets

- **Dynamic Controller (MPC)**
  - Inputs k
  - Processes Targets

**Graphs**

- **SOFA DAMPER / AIR FLOW**
  - Chart showing SOFA DAMPER and AIR FLOW over time.

- **CO**
  - Graph showing CO emission levels over time, with a maximum limit.
  - Fluctuations around the limit.

- **NOx**
  - Graph showing NOx emission levels over time, with minimal fluctuations.

**Dynamic Controller (MPC)**

- Process for controlling emissions effectively.

Wet FGD Optimizer

Goals:
• Use Power Perfecter to maximize SO$_2$ removal
• Maintain gypsum quality
• Minimize power usage
WFGD Simulation:

Basis: Dynamic simulation of WFGD process based on proprietary ALSTOM WFGD spray-tower steady-state design techniques and empirical dynamic observations.
Comparison of Control Schemes

Conventional PID/FF Controls

1-Day MPC Target

30-Day MPC Target

Time (126 days)

Inlet SO2 (lb/hr)

Outlet SO2 (lb/hr)

SO2 Emissions: 1 Day Rolling Average

SO2 Emissions: 30 Day Rolling Average

SO2 Emissions Target

Before

After
## Operational Summary of Control Schemes

### SO\textsubscript{2} Emissions (lb/hr)

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Maximum</th>
<th>Minimum</th>
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<tr>
<td><strong>Instantaneous</strong></td>
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<tr>
<td>Conventional PID/FF</td>
<td>504.8</td>
<td>488.7</td>
<td>153.2</td>
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<td>MPC: 1 Day Target</td>
<td>515.1</td>
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<td>511.5</td>
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<td>143.0</td>
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<td><strong>1 Hour Rolling Average</strong></td>
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<td>964.6</td>
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<tr>
<td><strong>1 Day Rolling Average</strong></td>
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<td>Conventional PID/FF</td>
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<td>MPC: 30 Day Target</td>
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<td>514.2</td>
<td>41.0</td>
<td>628.2</td>
<td>377.3</td>
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<td><strong>30 Day Rolling Average</strong></td>
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<tr>
<td>Conventional PID/FF</td>
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<td>519.2</td>
<td>28.3</td>
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<td>532.0</td>
<td>502.5</td>
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</table>

All Cases: Average Gypsum Quality: 95.2%
FGD Optimizer Benefits

• Increased SO₂ removal efficiency (2-5%)
• Decrease operation cost for limestone and power (2-5%)
• Maintain by-products quality
• Consistent operations
• Improved operations
• Improved maintenance
**FGD Benefits for a 600 MW Unit***

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Savings per Year</th>
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<tr>
<td>SO$_2$ Credit (2.5% improvement due to absorber control)</td>
<td>$400,000</td>
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<tr>
<td>Operational Savings for Power (4% reduction)</td>
<td>$67,000</td>
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<tr>
<td>Operational Savings for Limestone (2% reduction)</td>
<td>$87,000</td>
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<tr>
<td>Prevention of Limestone Blinding (2 incidents)</td>
<td>$182,000</td>
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<tr>
<td>Maintenance (Replacement of pH probes)</td>
<td>$65,000</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$801,000</strong></td>
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</tbody>
</table>

* 600 MW unit, 0.8 capacity, sulfur content of 2%, SO$_2$ credit of $165/ton.