Cormetech

SCR Catalyst Development for Low SO$_2$ to SO$_3$ Oxidation

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Governing Reactions

\[
4\text{NO} + 4\text{NH}_3 + \text{O}_2 \xrightarrow{\text{catalyst}} 4\text{N}_2 + 6\text{H}_2\text{O} \quad (1)
\]

\[
2\text{SO}_2 + \text{O}_2 \xrightarrow{\text{catalyst}} \text{SO}_3 \quad (2)
\]

Adverse affects caused by reaction (2):

- \(\text{SO}_3\) plume
- Increased corrosion
Drivers and Objectives

- **Drivers**
  - Reduced contribution to SO$_3$ plume
  - Reduced corrosion
  - Reduced cost for SO$_3$ mitigation reagent

- **Objectives**
  - Significant reduction in the formation of SO$_3$
  - Maintenance of catalyst properties
Catalyst Properties

NOx conversion reaction takes place within ~ 50 microns of catalyst surface due to fast diffusion of reactants (NH3, NOx, O2)

SO₂ to SO₃ Oxidation slow and therefore dependent on total bulk catalyst weight (V, W)
Catalyst Properties

- Homogeneous
  - Catalyst has high poison resistance
  - Delamination – not applicable
  - Erosion is controlled through material hardness
  - $\text{SO}_2$ oxidation is moderate with high open area product

- Coated
  - Efficiently utilizes catalytic material
  - Minimizes $\text{SO}_2$ oxidation
  - Delamination potential increased with use of non-similar materials
  - Minimal poison resistance when applied to non-porous substrate

Goal – Combine best properties of both catalyst types
Hybrid Catalyst Properties

Result: High Performance SCR catalyst with decreased SO$_2$ oxidation without sacrificing performance attributes
## German Plant Demonstration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit size/type, MW</td>
<td>705 – wall fired PC</td>
</tr>
<tr>
<td>Fuel</td>
<td>Bituminous</td>
</tr>
<tr>
<td>Catalyst Description</td>
<td>Hybrid - 7.1 mm pitch – focus on</td>
</tr>
<tr>
<td></td>
<td>Increase K @ low SO₂ to SO₃ oxidation</td>
</tr>
<tr>
<td>Gas Velocity, m/s</td>
<td>4.5</td>
</tr>
<tr>
<td>Temperature, deg C</td>
<td>380</td>
</tr>
<tr>
<td>SO₂ ppm</td>
<td>Nominal 500 Range 350-1000</td>
</tr>
<tr>
<td>SO₃ ppm</td>
<td>Nominal 10 Range 7 – 20</td>
</tr>
<tr>
<td>SO₂ to SO₃ oxidation</td>
<td>0.3% single layer</td>
</tr>
<tr>
<td>Dust Loading, mg/Nm³</td>
<td>Design 10,000 Range 5,300 – 25,000</td>
</tr>
</tbody>
</table>
German Plant Catalyst Sample

After ~ 45,000 Operating Hours
SEM Image - Wall Cross-section

After ~ 45,000 hours Exposure

- Catalyst Wall
- Interface
- Surface treatment

~ 1 mm
SEM Image - Wall Cross-section @ Front

Fresh - Unexposed

After ~ 45,000 hours
SEM Image - Wall Cross-section @ Rear

Fresh - Unexposed

After ~ 45,000 hours
German Reference Plant - K/Ko vs. Time

Operating Time, hours

K/Ko

Actual Performance

Guarantee Point
Innovative Products to Meet Customer Needs

Advanced Extrusion Techniques alone or in Combination with Surface Treatments Results in:

- Increased NOx Activity
- Decreased SO$_2$ to SO$_3$ Conversion
- Decreased impact on SO$_2$ to SO$_3$ conversion caused by vanadium deposition.
SO$_2$ to SO$_3$ Oxidation vs. Product

Design Reference
Inlet NOx = 0.5 lb/mmbtu
Removal Efficiency = 90%
NH$_3$ slip = 2 ppm
Conclusions

- Durability was commercially demonstrated for an extruded, surface-treated, SCR catalyst.
  - Chemical – activity was maintained
  - Physical – high integrity of surface

- Lower SO$_2$ to SO$_3$ oxidation is achievable.
  - 65% decreased rate with advanced products
  - <0.2% oxidation possible in some cases
What Next?

What are the Customer Requirements?

- Oxidation rates
- Schedule
- Economic Impacts
  - Reagent reduction
  - Reduced corrosion