SCR/CO/VOC Control for the McIlvaine Company

A short overview of Emission Control Systems for Gas Turbines

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**Principle of SCR Reaction**

(Denitrification Process)

4NO + 4NH₃ + O₂ → 4N₂ + 6H₂O
NO + NO₂ + 2NH₃ → 2N₂ + 3H₂O

2 CO + O₂ → 2CO₂
wVOC + xO₂ → yCO₂ + zH₂O
Add’l Scope
• AFCU
• PLC
• Tech Advisor
• Training

Options
• Ammonia Tank
• Pump Skid

Guarantee
• NOx; CO; VOC
• Utility
• dP
• Noise
• Catalyst Life

SCR FOR SIMPLE CYCLE GT
(TYPICAL SCOPE)
Design Considerations:

- Seismic and Wind Loads
- Thermal Growth
- Catalyst Support & Sealing
- Accessibility (Internal and external components)
- Thermal Insulation & Liner System
- Prefabrication – Modular - Panel - Semi Modular
- Constructability – TIME & MONEY
- Operation & Maintenance
PLANT A (MODULAR CONSTRUCTION)
PLANT B (Panel Construction)
Plant C (Semi-Modular Construction)
### Key Considerations for Gas Turbines SCR

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Service life – Hours &amp; Years (customer requirement)</td>
<td>Ammonia slip</td>
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<tr>
<td>Exhaust gas temperature</td>
<td>Catalyst temperature</td>
</tr>
<tr>
<td>Turbine exhaust NO$_x$, CO, VOC levels</td>
<td>Reactor duct configuration</td>
</tr>
<tr>
<td>Required NO$_x$, CO, VOC removal &amp; stack exit</td>
<td>Flue gas flow/temperature distribution</td>
</tr>
<tr>
<td>Pressure loss allowance</td>
<td>SO2 to SO3 Conversion</td>
</tr>
<tr>
<td>Volumetric flow rate</td>
<td>NH$_3$/NO$_x$ distribution</td>
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CATALYST SELECTION: TEMPERATURE

- **High temp catalyst:** 450°F ~ 1,100°F
- **Medium temp catalyst:** 450°F ~ 900°F
- **Medium-low temp catalyst:** 450°F ~ 850°F
- **Standard catalyst:** 450°F ~ 800°F

At higher temperature, reduce V:W ratio for
- Stronger NH₃ adsorption
- Lower NH₃ decomp rate
- Higher DeNOₓ rate
- Lower sintering rate

Large operating temperature range (350 - 1100°F)
Catalyst Modules & Test Coupons/Blocks

Typical Sampling Coupon

Typical Sampling Basket
• Platinum or other PGM promotes CO to CO$_2$ oxidation.

• Brazed joint corrugated metallic foils, stacked corrugated foil or ceramic cells to provide high surface area per cu.ft. of catalyst

• Oxidation occurs on “surface” of catalyst.

• Pressure drop is directly dependent on catalyst depth and compactness
## Catalyst Poisoning & Degradation Mechanism

<table>
<thead>
<tr>
<th>Degradation Source</th>
<th>Mechanism</th>
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<tbody>
<tr>
<td>High Temperature &gt; 930°F</td>
<td>Decreases available surface area by thermal sintering of ceramic material</td>
</tr>
<tr>
<td>Fine particulate</td>
<td>Reduces available surface area by masking surface and preventing diffusion into pre structure</td>
</tr>
<tr>
<td>Ammonia-sulfur compounds</td>
<td>Plugs pores and prevents diffusion</td>
</tr>
<tr>
<td>Alkaline metals, Na, K</td>
<td>Ion exchange with active sites</td>
</tr>
<tr>
<td>Alkaline earth metals, Ca, Mg</td>
<td>Typically in form of sulfates, bond with acid sites reducing the ability of catalyst to absorb NH$_3$ i.e. formation of CaSO$_4$</td>
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<tr>
<td>Halogen</td>
<td>May react with and volatilize active metal sites</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Gaseous arsenic diffuses into catalyst and covers active sites, preventing further reaction</td>
</tr>
<tr>
<td>V, Pt, Cr and Family</td>
<td>Deposit onto catalyst, increasing NH$_3$ to NO and/or SO$_2$ to SO$_3$</td>
</tr>
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</table>
Flue Gas Path Management (NH$_3$ Mixing - Cold Flow Model)

Simple Cycle Physical 1/12th Scale Model
Flue Gas Path Management (Tempering Air Mixing - CFD)

Simple Cycle CFD Model
Project Features

- Frame SCGT x 4 units
- Max operating temp: ~1150°F
- Tempering Air
- Outlet NOx: 2.5 ppmvd
- Completed April 2013
SUMMARY

- MPSA has established SCR design considerations for gas turbine fired applications and can ensure long-term and continuous system operation on gas or liquid fuels.

- Mitsubishi has supplied SCR systems for combined cycle and simple cycle gas turbines globally, and is a “Proven” technology provider with over 600 SCR systems worldwide.

- MPSA has a team of qualified experts in Newport Beach and Lake Mary Office with access to more experts at MHI Nagasaki and MHI R&D. We can offer support with feasibility studies, with project execution, and with long term maintenance of your valuable investment.