Mitigation of SCR Impacts on Fuel Flexibility Using Targeted In Furnace Injection (TIFI)

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McIlvaine Hot Topic
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Agenda

• Impact of catalyst technology on fuel flexibility
• Overview of Targeted In Furnace Injection TIFI®
• Demonstrated Benefits of TIFI® on boiler and SCR operation
• Conclusions
Impact of SCR on Boiler Operation and Fuel Flexibility

- Minimum Operating Temperature MOT
  - Determined by ABS formation temperature (to protect catalyst from masking)
  - MOT may impose restrictions on unit minimum load, NOx removal efficiency (NH₃ injection rate) and fuel quality (Sulfur content)

- Downstream impacts of Ammonia Slip and SO₃
  - Fouling (delta-P), Corrosion, Byproduct Quality ($), Visible Emissions (Environmental)

- Catalyst poisons
  - Fuel flexibility and Catalyst life ($)
Minimum Operating Temperature

- The MOT of the catalyst depends on the SO\textsubscript{3} and ammonia concentration in the flue gas
- The ammonia concentration is a function of the NO\textsubscript{x} removal
Impact of $\text{SO}_3$ on NO$_x$ Reduction

- MOT impact at 200 PPM NO$_x$ Reduction
TIFI® Targeted In-Furnace Injection™

- Highly reactive magnesium hydroxide \( \text{Mg(OH)}_2 \)
- Patented process using Computational Fluid Dynamic Modeling
- Critical Design Criteria
  - Furnace gas flows and temperatures
  - Chemical distribution, particle size and feed rate
CFD Modeling of Injection Strategy includes both Furnace and Backend

TIFI Injection Model

SO₃ Distribution Map
ANATOMY OF A TYPICAL INJECTION SYSTEM

Tank

BOOST/RECIRC

CHEMICAL METERING

AIR

WATER

MANIFOLDS

INJECTORS

TIFI® Targeted In-Furnace Injection™
TIFI reduces ABS, SO$_3$, and H$_2$SO$_4$

- Lower Furnace Temperature
  - Decreased SO$_2$ Oxidation Rate
- More Balanced Furnace
  - Reduced Excess Oxygen
- Reduced Slag and Iron Deposits
  - Less Catalytic Oxidation of SO$_2$
- Direct Reaction with MgO
  - MgO + SO$_3$ $\rightarrow$ MgSO$_4$
  - MgO + NH$_4$HSO$_4$ $\rightarrow$ MgSO$_4$ + NH$_3$ + H$_2$O
Case Studies

Demonstration of TIFI with SCR
Control of Hard Slag Formation

Fuel Characteristics – SO2 3.3-4.5 #mmBtu; Iron Content (in ash) 23-25%

- Treated slag material is more friable
- More easily and thoroughly removed with existing soot blowing
- Mitigates formation of Large Particle Ash/Popcorn Ash
- Reduces build up of catalytic metals in the furnace
- Generous improvement of boiler efficiency
Control of LPA/SCR Pressure Drop

**NET MW vs. SCR DP**

- Baseline
- TIFI Treatment

**Graph Details**
- X-axis: DATE
- Y-axis: NET MW
- Axes: DP (in. H2O)
- Lines:
  - Net MW
  - SCR "A" DP
  - SCR "B" DP
SO$_3$ Mitigation with TIFI

- **Economizer Outlet**: Baseline 50, Treated 50 lbs/Ton
- **SCR Outlet**: Baseline 200, Treated 200 lbs/Ton
- **Air Heater Outlet**: Baseline 10, Treated 10 lbs/Ton
TIFI Clean up Of Air Heater

- TIFI virtually eliminates precipitation of ABS in the AH
Online ABS Removal from Air Heater

AH pressure drop decreased from 17.8” to 14.7”
- Ammonia Slip ranged from 3-15 ppm
- SCR dP and Air Heater dP controlled for 19 months
Arsenic Poisoning Mitigation

Gaseous Arsenic is a predominant deactivation mechanism for SCR catalyst in coal fired applications (source E-ON 2010)

Low concentration of alkaline metals in the fuel can exacerbate deactivation by Arsenic.
  • TIFI provides alkaline metal (Mg) to mitigate

Higher flue gas temperatures can exacerbate deactivation by Arsenic.
  • TIFI improves furnace heat recovery and allows lower MOT

Higher concentrations of $\text{SO}_3$ can exacerbate deactivation by Arsenic.
  • TIFI effectively reduces $\text{SO}_3$
Conclusions

• TIFI® Targeted In-Furnace Injection™ Successfully controlled slag, fouling, SO$_3$, & ABS
• Prevented ABS Formation, and removed ABS from a Fouled Air Heater
• Catalyst Life Significantly Extended by maintaining low SCR & AH dP
• Ammonia slip is managed - preventing need to buy new catalyst prematurely
• TIFI mitigates several contributors to catalyst deactivation by gaseous Arsenic
**NOx Reduction Technology Suite**

- **Advanced Combustion Technologies**
  - Combustion Modifications: LNB, ULNB, FGR and OFA Systems

- **Selective Non-Catalytic Reduction**
  - RRI (Rich Reagent Injection)
  - NOxOUT® SNCR
  - HERT (High Energy Reagent Technology)

- **Catalyst Technologies**
  - Urea-based and NH3-based* SCR for Industrial Applications
  - NOxOUT CASCADE®: SNCR + SCR Hybrids
  - Advanced SCR Systems
  - NOxOUT ULTRA®: Thermal Decomposition of Urea
  - SCR Design and Application Consulting, Catalyst Mgmt Services

*Note: Recent development for small NH₃ flow SCRs under 10,000 pounds of reagent storage.
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