July 14, 2016

I-NOx™ Integrated NOx Reduction Technology

McIlvaine PacifiCorp Webinar No. 1
COMMERCIAL PRODUCTS

Fuel Tech Technologies

- ASCR™: Advanced SCR system which combines LNB + OFA + SNCR + AIG + GSG™ + Catalyst
- AIG: Ammonia Injection Grid
- GSG™: Graduated Straightening Grid
- HERT™: SNCR system using high energy injectors
- LNB: Low NOx Burners
- NOxOUT®: SNCR system using high momentum injectors
- ULTRA™: Urea-based ammonia generation system for SCR
- SCR: Selective Catalytic Reduction
- SNCR: Selective Non-Catalytic Reduction

Non-Fuel Tech Supplied

- SCR Services: Selective Catalytic Reduction Services which include: optimizing process design, catalyst selection, and improving the overall performance of SCR
- Static Mixer: Equipment used to mix temperature, velocity, and NOx to optimize SCR performance ahead of the AIG
- TIFI® Targeted In-Furnace Injection™: Chemical Injection Programs used to target slag control SO3 mitigation, and fuel flexibility

Reagent Systems for SNCR and SCR (ULTRA™)

Flue Gas Flow Troubleshooting & Ash Mitigation

Advanced Modeling Services – All Technologies

SCR Design and Catalyst Management Services

ESP Rebuild and Flue Gas Conditioning Systems

Confidential
FUEL TECH’S I-NOx TECHNOLOGY

- Combustion Modifications
  - Low NOx Burners and Over Fire Air for Wall Fired Units
  - Combustion Modifications and Separated Over Fire Air for T-Fired Units
  - Additional Modifications and Combustion Tuning to Reduce NOx Further

- Selective Non-Catalytic Reduction of NOx (SNCR)
  - In-Furnace Injection – Furnace is Reactor
  - Low Capital Cost
  - Additional NOx Reduction / Optimized Reagent Consumption when Combined w/ASCR

- ASCR™ Advanced Selective Catalytic Reduction of NOx
  - Single Layer of Catalyst Where Applicable
  - In-Duct Arrangement with Proper Flow and Ash Distribution

- Combining Multiple Technologies Requires Technical “Know-How” and Commercial Experience
I-NOx CHALLENGES AND BENEFITS

• Design Must Be Truly Integrated:
  - SNCR Design Must Account for Combustion Output and Varying Operational Conditions of Typical Boiler
  - SCR Design Must Account for SNCR Output and Varying Operational Conditions of the In-Furnace Combustion and SNCR Systems as Boiler Conditions Fluctuate

• Challenges:
  - Physical Space Limitations for In-Duct Reactor
  - Highly Maldistributed NOx and NH₃ from Boiler
  - Increased SCR Velocity Due to Restrictions in Catalyst Installation Space
  - Both Require Expert Knowledge in the Design of All of the Technologies being combined
  - Computational and Experimental Fluid Dynamics Modeling Coupled with Flow Distribution Device Optimization

• Benefits:
  - Integrated Technologies Provide Lower Capital Cost w/ NOx Reductions Ranging from 50 – 80%
  - Optimized Reagent Consumption, Lower dP, Reduced Catalyst Replacement, Lower SO₂-SO₃ Oxidation, Lower Minimum Operating Temperatures, Etc.
FUEL TECH I-NOx COMMERCIAL EXPERIENCE

- Reliant Energy Seward Station (1999)
  - 147 MW T-Fired Unit
  - SNCR + SCR, 55% NOx Reduction
- AES Greenidge (2005)
  - 115 MW T-Fired
  - Significantly Improved Chemical Utilization w/ASCR
  - Combustion Modifications + SNCR + ASCR, >60% NOx Reduction
- China Light and Power Castle Peak (2010)
  - Four (4) 680 MW Wall Fired Units
  - Boosted OFA, ASCR, and ULTRA Urea Conversion
  - ASCR Provided 40% NOx Reduction
- China Steel Corporation, Taiwan (2014)
  - Three (3) 80 MW T-Fired Units
  - Four (4) Sub-Systems Deployed – Combustion Modifications, New SOFA System, SNCR, and ASCR
  - > 78% Total NOx Reduction
Question & Answer - Thank You