Dry Sorbent Injection and Gas Co-Fire / FLGR for Small to Medium Plants

McIlvaine Hot Topic Hour:
Dry Sorbents and Systems and Material Handling in Coal-fired Power Plants

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The Balance of Power

**Regulations:**
- MATS
- CSAPR
- NAAQS
- Coal Residuals
- Wastewater
- GHG BACT

**Economics:**
- Fuel Cost
- Fuel Flexibility (Coal V/S Gas)
- Cost of Compliance
- Demand
- Repower?
- Retire Plants?
Regulatory Compliance

- **MATS (in effect)**
  - HCl (0.002 Lb/MMBtu) (SO$_2$ Surrogate – 0.2 lb/MmBtu)
  - Hg (1.2 Lb/Tbtu)
  - PM (0.03 lb/MMBtu)

- **CSAPR (Currently Stayed)**
  - SO$_2$ (Reduction of Approx 50 to 60 % from 2005 Levels)
  - NO$_x$ (Reduction of Approx 40 to 50 % from 2005 Levels)
Plants with SCR + Scrubber

- **MATS**
  - HCl (Scrubber)
  - Hg (SCR – Oxidizes; Scrubber – Captures)
    - ACI to Augment as necessary; *DSI can help with SO$_3$ interference*
  - PM (SO$_3$ contributes to Method 5)
    - *DSI can help*

- **CSAPR**
  - SO$_2$ (Scrubber)
  - NO$_x$ (SCR)

- *In general, there is a path to compliance*
Plants without SCR & Scrubber
Typically 300 MW and below

- **MATS**
  - HCl (*DSI*)
  - Hg (ACI + *DSI for SO$_3$*)
  - PM (*DSI for SO$_3$*)

- **CSAPR**
  - SO$_2$ (*DSI?*)
    - Sodium Bicarb can deliver 90% reduction. ESP Loading and Flyash sales are a concern
    - Hydrated Lime can deliver 50 to 70% reduction. ESP Loading is a concern
  - NO$_x$ (SNCR?)
    - SNCR performance is limited to less than 30% and inconsistent based on temperature fluctuations and boiler operations

- **In general, not many good options available. DSI is not viable by itself.**
Maybe a Sequential Approach would work?

1. Convert some heat input to gas to realize SO\textsubscript{2} and NO\textsubscript{x} reductions and take advantage of lower fuel pricing

2. Couple the entire combustion output with FLGR to reduce Nox with an additional SO\textsubscript{2} drop,

3. Polish the SO\textsubscript{2} with DSI now that the net particulate is reduced
Partial Natural Gas Conversion

Natural Gas Co-Fire
Co-Fire?

- **Uses Existing Major Assets:**
  - No Heat Transfer Modifications or Derates required
  - Allows for Fuel Flexibility as Coal/Gas Pricing moves

- **Dispatch Consideration**
  - Gas in Upper Registers can improve Load Ramp and Superheat Temperature control
  - Gas in upper registers may allow for reduced MSL

- **Co-Firing will require flexible modifications to burners**
  - Should be accomplished mill by mill
  - Introduction of natural gas ports surrounding the main coal pipe
Fuel Lean Gas Reburn
Fuel Lean Gas Reburn (FLGR)

- Injects 3 to ~10% of Fuel into Upper Furnace
- Locally Fuel-rich Pockets within Fuel-lean Upper Furnace
- 3 - 5% NO\textsubscript{x} Reduction for each 1% Fuel

Commercially applied in 13 Utility Boilers!
Natural Gas Injected in Upper Furnace in amount sub stoichiometric to total flue gas oxygen,

Localized gas pockets create fuel RICH zone where CH$_4$ reduces NO$_x$ to NH + CO + H$_2$O

Upon re-entrance into O$_2$ rich zones, CO completes to CO$_2$

When passing the 1750 F temperature zone, some NH compound provides a secondary SNCR action
FLGR Performance:

Up to 30% NO\textsubscript{x}

Amine-Enhanced FLGR (AE-FLGR) can deliver 50% NO\textsubscript{x} reduction

SO\textsubscript{2} equal to Gas Rate
Dry Sorbent Injection

Hydrated Lime/Sodium Bicarbonate
Equipment and Layout
A Great deal is known about this work:

- Removal rates up to 90+% with SBC
- Removal rates between 50% and 70% with Hydrate
- Effects on fly ash utilization potential
- Effects on particulate collection system
- Effects on ash handling system
Achieving Compliance: Co-Fire

- **Co-Fire @ 25%**
  - SO$_2$ Reduction: 25%
  - NO$_x$ Reduction: 20%
  - Flyash reduction: 25%
Achieving Compliance: FLGR

- **Gas Injection Rate @ 10%**
  - SO$_2$ Reduction: 10%
  - NO$_x$ Reduction: 30%
  - Flyash Reduction: 10%
• \( \text{SO}_2 \) reduction required = 25% of base or 40% of remaining

• Easily achieved by DSI

• Additional Particulate loading of DSI <= reduction in flyash
Other benefits of Gas Co-Fire

- **Hidden advantages**
  - Improved load following and low load turn-down,
  - Improved ignition system and warm-up,
  - Increased peaking, and Unit capacity & reliability,
  - Better SH/RH control,
  - Reduced fan loading of both primary & secondary fans,
  - Reduced fuel inventory,
  - More uniform and increased flame zone O$_2$,
  - Consequently reduced slag formation problems.

- **Operating advantages**
  - Lower O$_2$ operation,
  - Reduced SO$_3$, acid, air-heater, back-end and plume problems,
  - Reduced LOI, leading to cleaner ash and better ESP operation,
  - More salable ash,
  - Dedicated fuel supply contracts.
Comclusions

• DSI is a useful technology for HCl and SO$_3$ mitigation for plants with SCR and Scrubber
• DSI can be a viable technology for compliance for plants without an SCR and Scrubber as part of a package that includes Gas Co-Fire and FLGR

Questions?