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

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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

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- **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.**

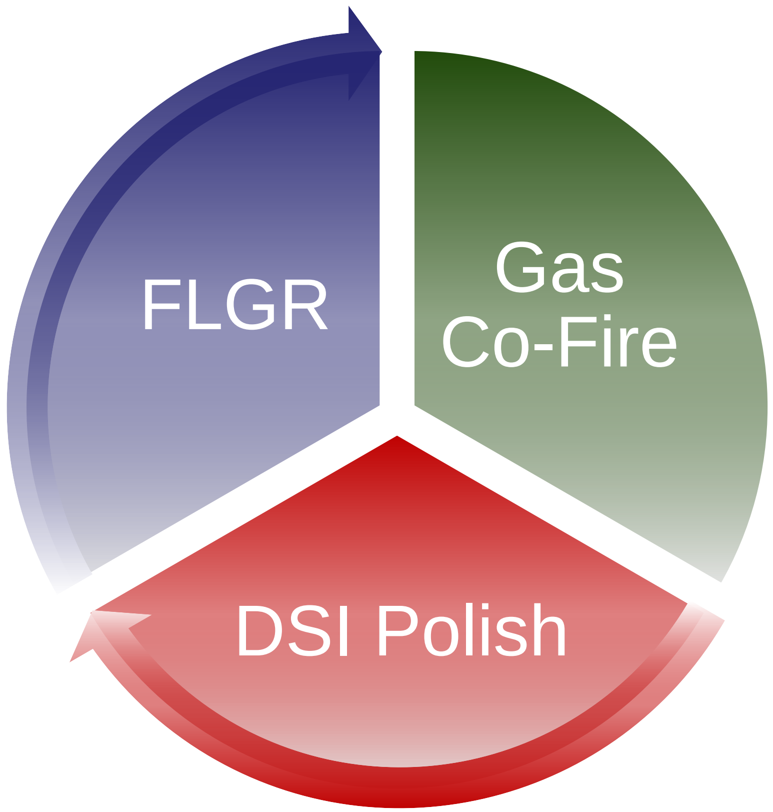
Component Approach

Maybe a Sequential Approach would work?

1. Convert some heat input to gas to realize SO_2 and NO_x reductions and take advantage of lower fuel pricing

2. Couple the entire combustion output with FLGR to reduce Nox with an additional SO_2 drop,

3. Polish the SO_2 with DSI now that the net particulate is reduced



Partial Natural Gas Conversion

Natural Gas Co-Fire

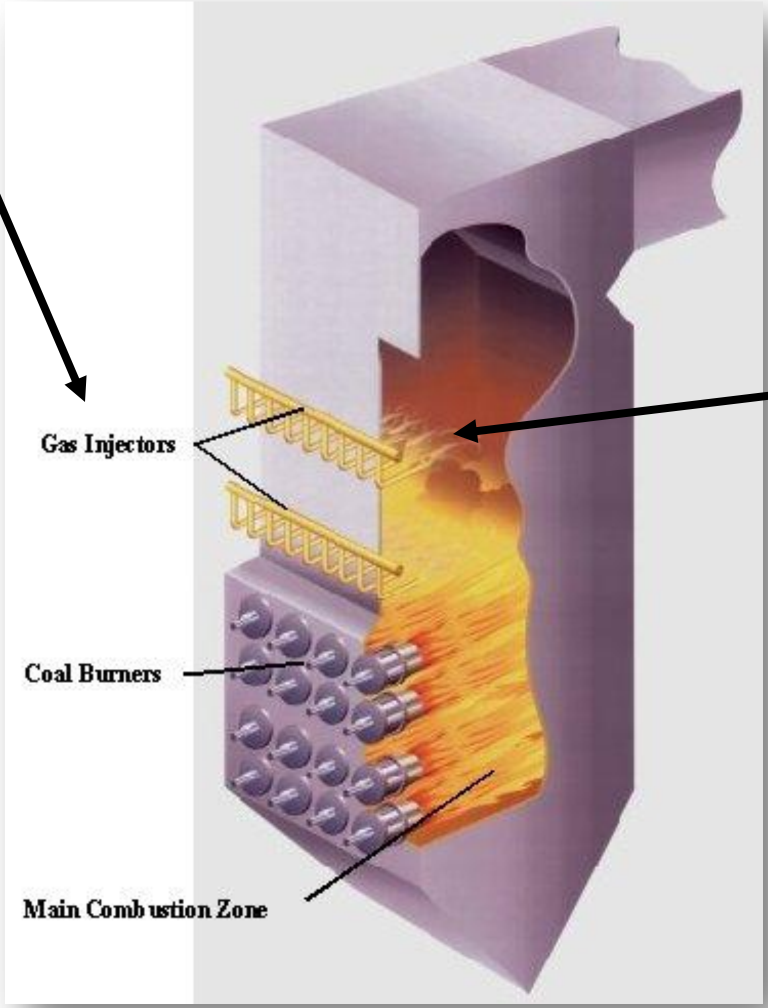
Co-Fire?

- **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**



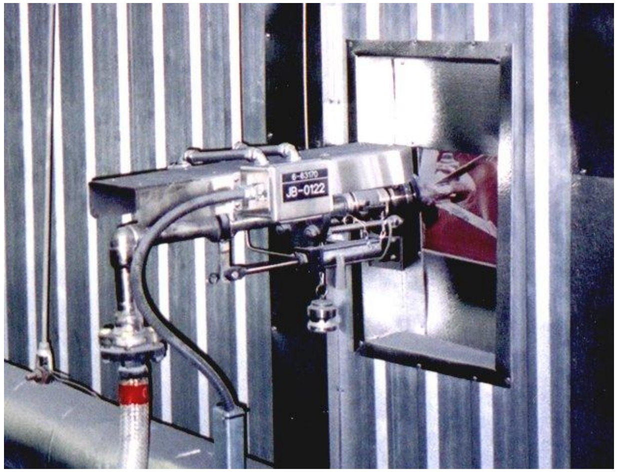
- Locally Fuel-rich Pockets with-in Fuel-lean Upper Furnace
- 3 - 5% NO_x Reduction for each 1% Fuel

Commercially applied in 13 Utility Boilers!

Rough Chemistry

- 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_2O
- 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

13 Installations – Proven Performance



FLGR Performance:

Up to 30% NO_x

Amine-Enhanced FLGR (AE-FLGR) can deliver 50% NO_x reduction

SO_2 equal to Gas Rate

Dry Sorbent Injection

Hydrated Lime/Sodium Bicarbonate

Equipment and Layout

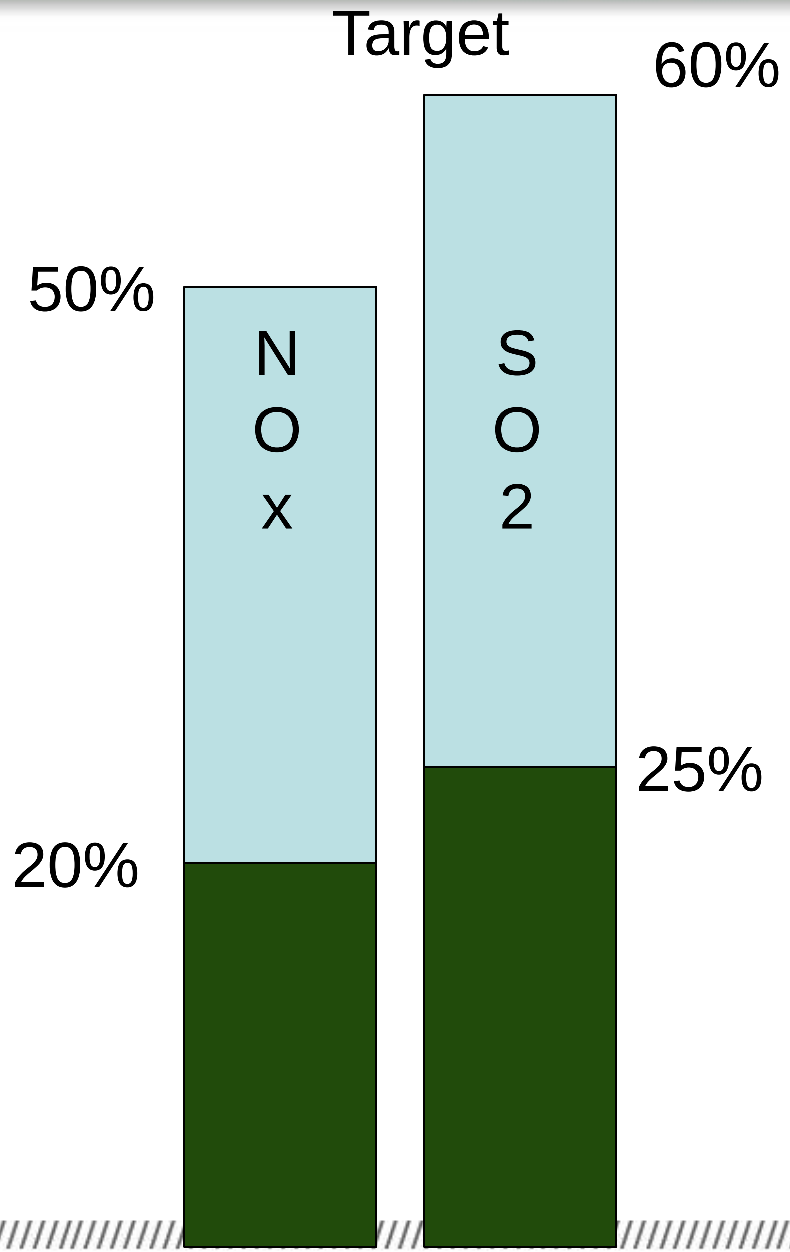
Equipment and Layout

DSI for SO_2

- **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

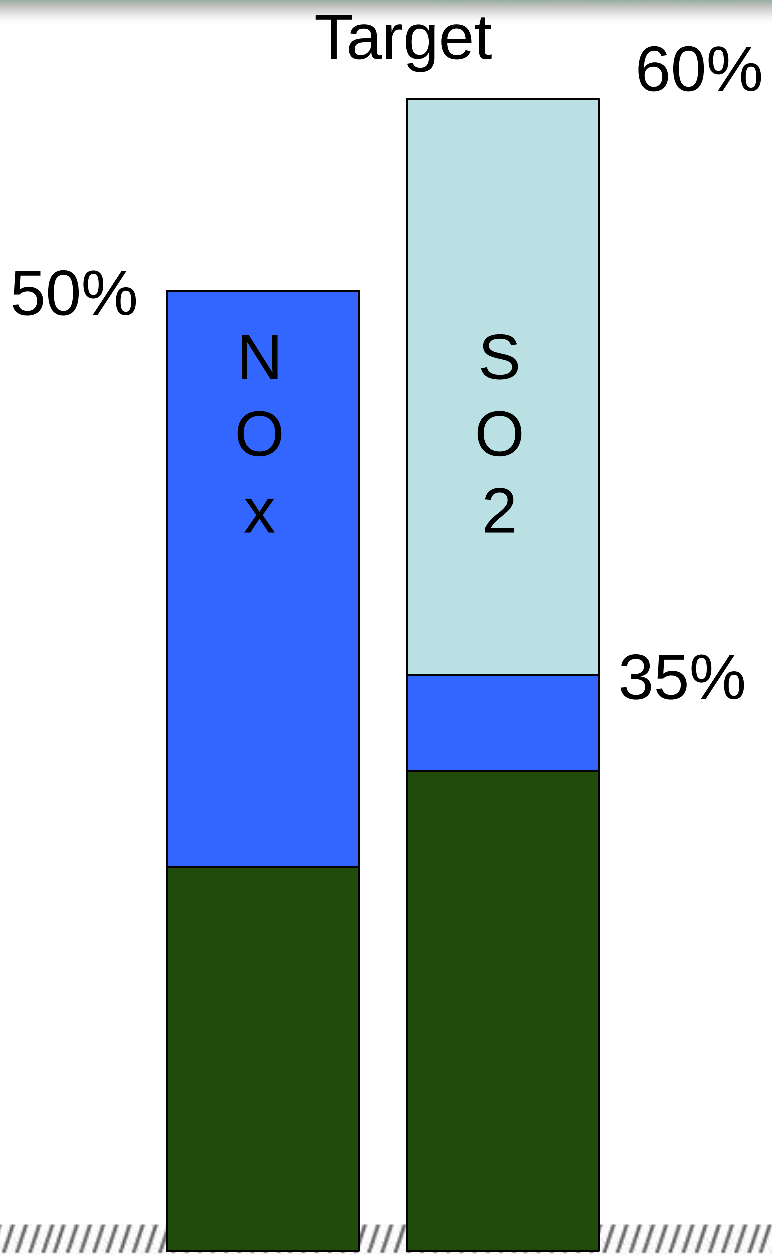
Achieving Compliance : Co-Fire

- **Co-Fire @ 25%**
  - SO_2 Reduction: 25%
  - NO_x Reduction: 20%
  - Flyash reduction: 25%



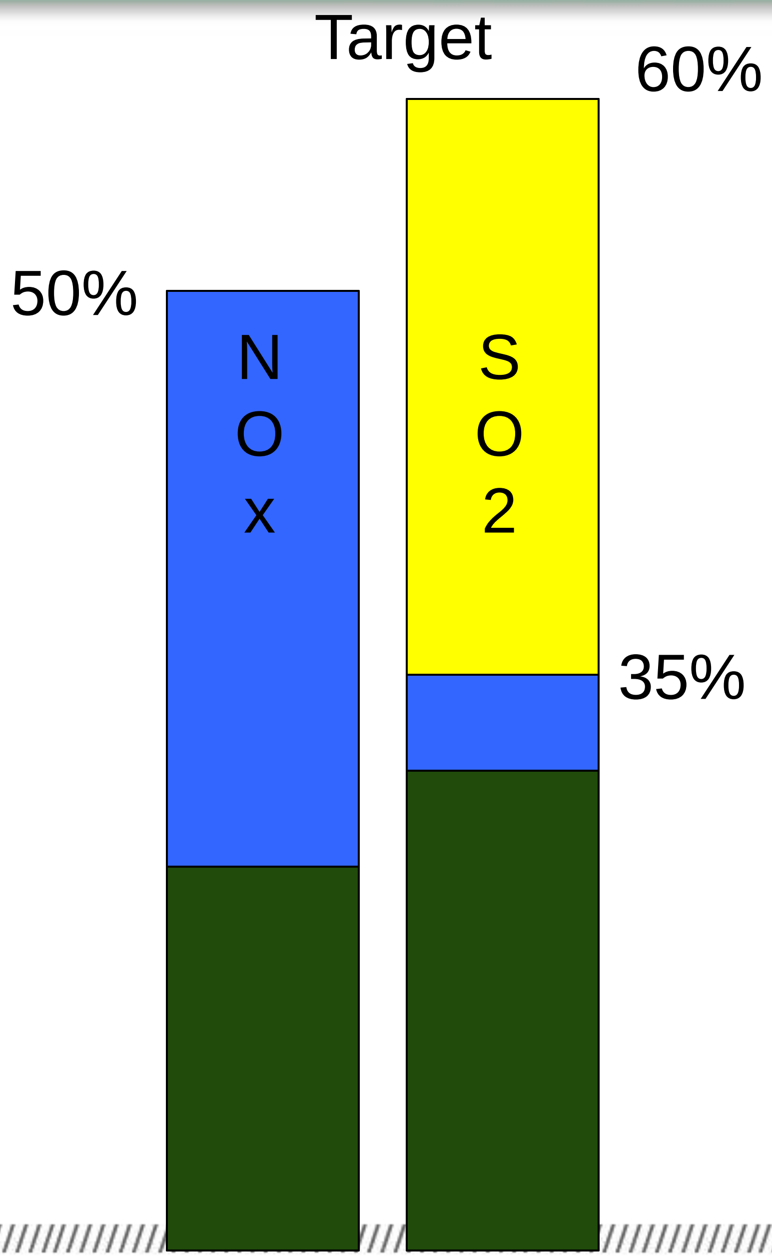
Achieving Compliance : FLGR

- **Gas Injection Rate @ 10%**
  - SO_2 Reduction: 10%
  - NO_x Reduction: 30%
  - Flyash Reduction: 10%



Achieving Compliance : DSI

- 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

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- **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?