REINHOLD ENVIRONMENTAL Ltd.

2019 REINHOLD Round Table Presentation

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Effects of Dual Fuel Firing on Backend Equipment

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AECOM

2019 REINHOLD Round Table, Birmingham, AL

Workshop 27, 11:00 – 12:00

June 25, 2019

Dual Fuel Operation

- What is dual fuel operation?
  - Firing coal and natural gas, separately and as a blend
- Why dual fuel operation?
  - Impact of fuel price and cost of generation
  - Increases fuel flexibility
  - Creates market opportunities
- Considerations of dual fuel operation
  - Natural gas supply
  - Boiler efficiency
  - Safe and reliable operation of backend equipment

Let's Focus on Backend Equipment

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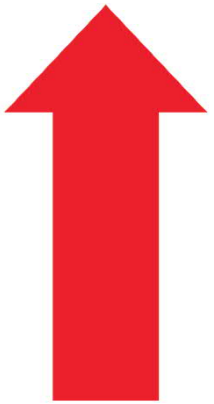
Impact of Offsetting Coal with Natural Gas

- Flue Gas Parameters that Decrease
  - NO_x, Hg, SO_2, SO_3, PM Concentrations
  - Flow rate (typically a small reduction)

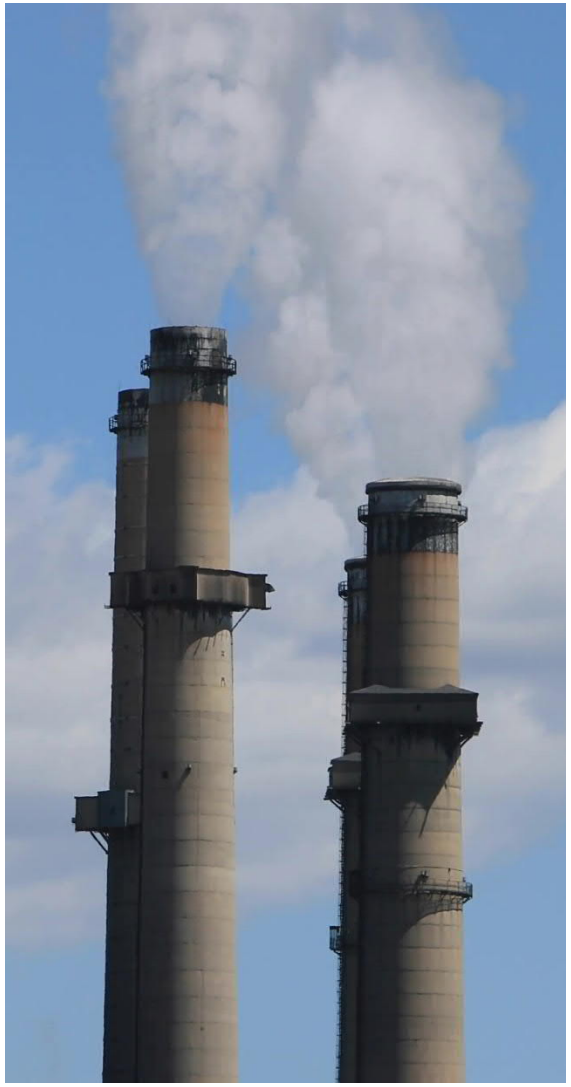
- Flue Gas Parameters that Increase
  - Moisture Content
  - Adiabatic Saturation Temperature



Backend Equipment Considerations

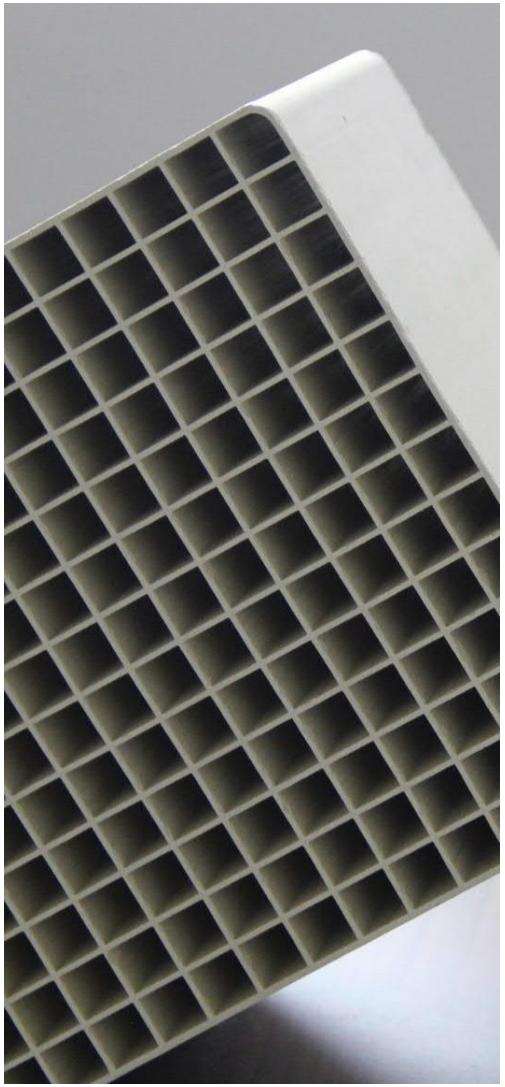
- What are the impacts of these changes on the system...
  - ✓ Design
    - e.g., personnel safety, thermal expansion, materials of construction,.
  - ✓ Control
    - e.g., operating temperature, alarm settings, etc.
  - ✓ Operation
    - e.g., turndown, transition between coal and natural gas, etc.

All of these items combine to affect AQCS:
SCR, DSI/PAC, PM Device, FGD, WWT



Impacts from Firing NG – NO_x Control

- Lower NO_x levels = reduced NH_3 injection rate
  - NH_3 turndown can be ≥ 10x design
  - Requires feed system modifications
- Impact on SCR Minimum Operating Temperature (MOT)
  - Work with catalyst vendor to determine impact of dual fuel operation (NOx and SO_3 levels) on MOT
  - Maintain SCR inlet temperature above MOT based on fuel blend
- Boiler Primary Air Fan
  - PA fan operation may not be required when firing 100% natural gas

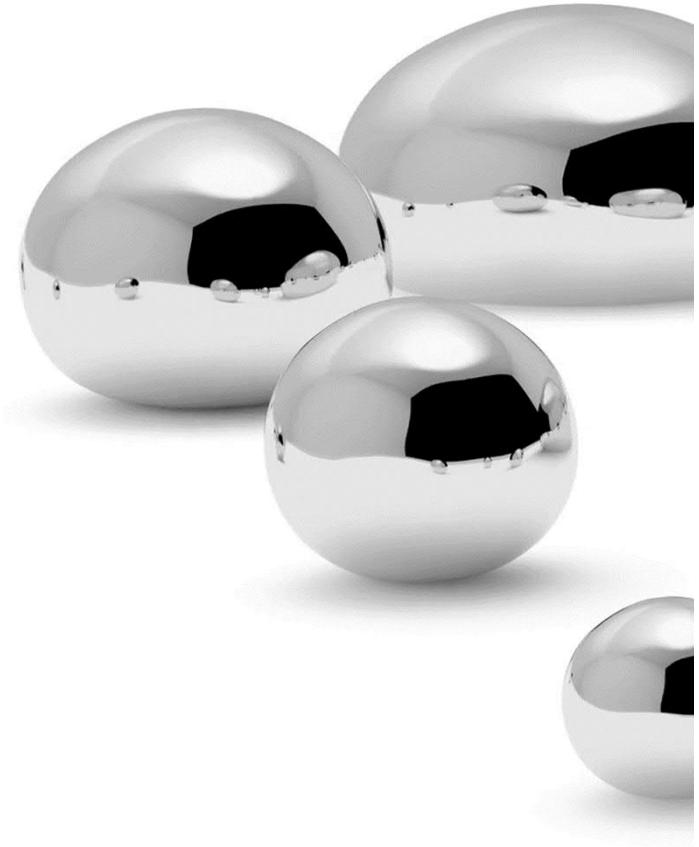


Impacts from Firing NG – SO_3 & Hg Control

- SO_3 Control
  - Lower SO_3 = additional turndown needed
  - Less fly ash & sorbent injection = longer duration between cleaning cycles

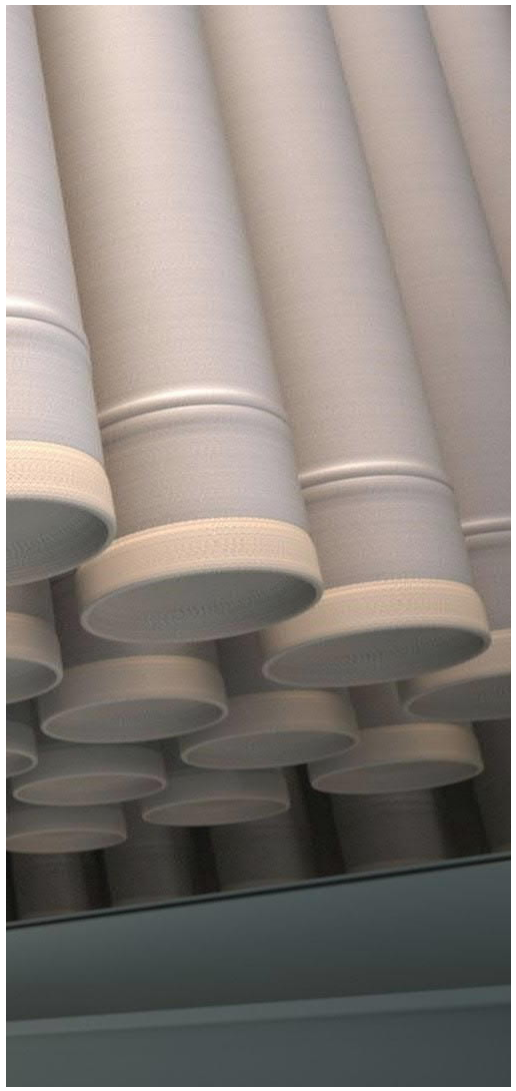
- Hg Control
  - Lower Hg, SO_3 & Temp = additional turndown needed
  - Less fly ash = less native removal
  - Lower halogens in flue gas = lower Hg oxidation across SCR
  - Dilute WFGD Absorber Slurry = Hg re-emissions during transitions

- If you have a fabric filter, there's a need to retain "cake" thickness for SO_3 & Hg removal



Impacts from Firing NG – PM Control

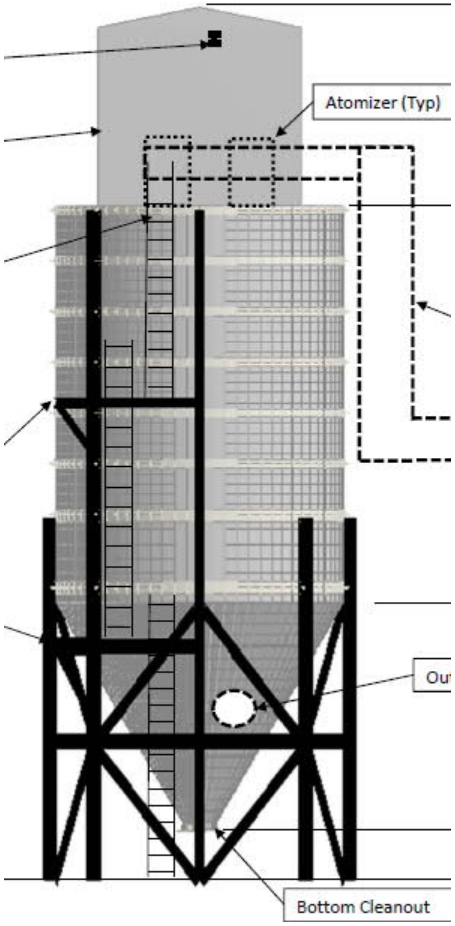
- PM loading decreases as the percentage of NG fired increases
- Impact of sorbents for SO_3 / Hg control on PM loading & ratio of ash to sorbent
- Ash resistivity changes with flue gas SO_3, moisture & temperature
- Operation of the PM Control device needs to be adjusted based on changing conditions
  - For ESPs – # of fields in service
  - ESP Gas Conditioning System Turndown
  - For FFs – consideration must be given to dP, cake thickness and minimum approach temperature (avoid condensation)



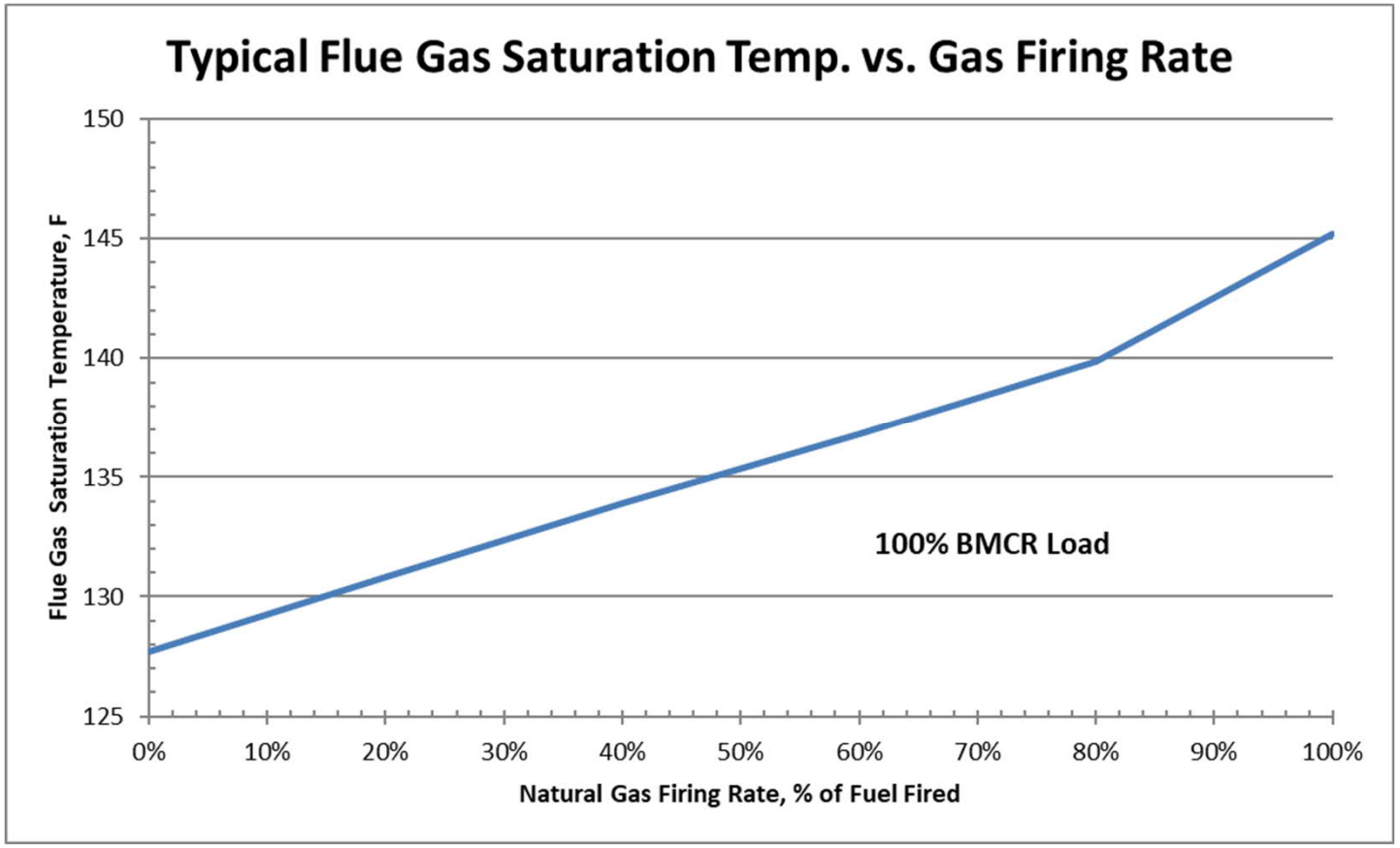
Impacts from Firing NG – SO_2 Control

Spray Dryer Absorbers (SDA) and Circulating Dry Scrubbers (CDS)

- Impact of increasing moisture content
  - Higher saturation temperature
    - Requires adjustment to SDA / CDS operating temperature to maintain required approach-to-saturation temperature
  - Reduces amount of water evaporated
- Requires operational and possibly design modifications for effective turndown
- At 100% natural gas, may be able to discontinue operation



Adiabatic Temperature vs. Fuel Mix



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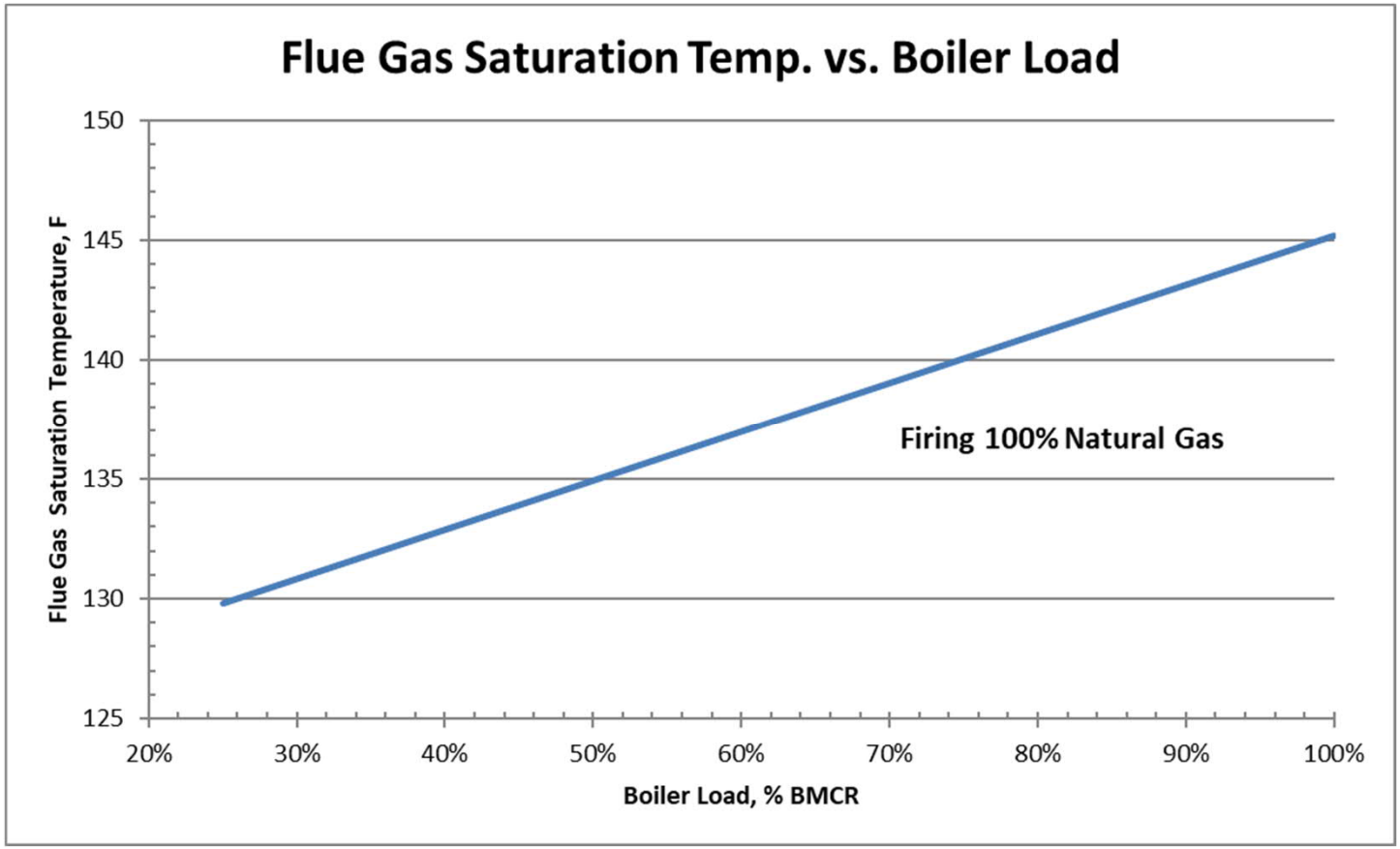
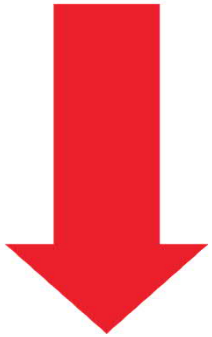
Adiabatic Temperature vs. Load

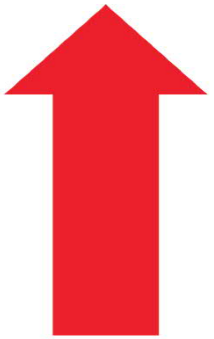


Impacts from Firing NG – SO_2 Control (Wet FGD)

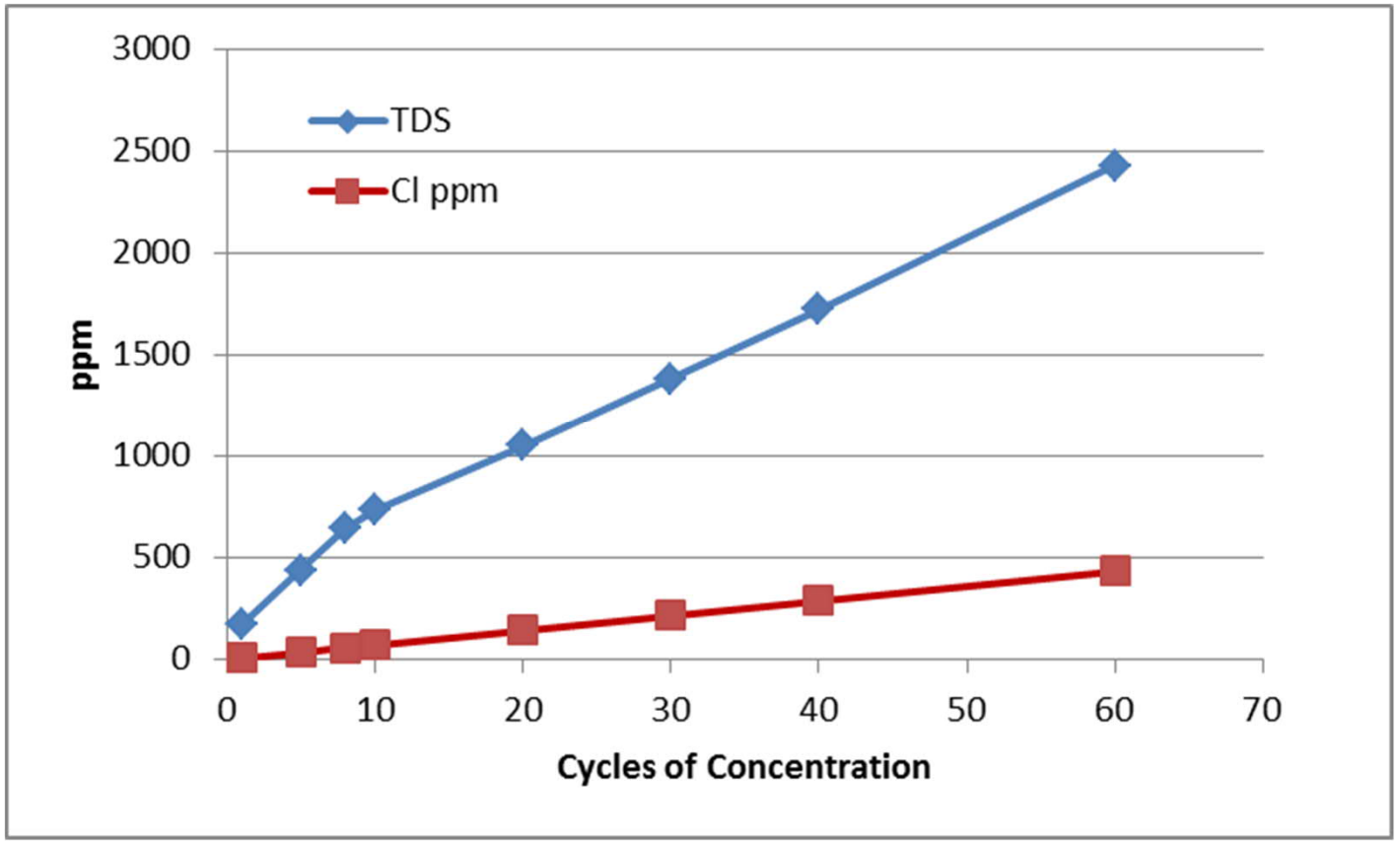


- Parameters that Decrease
  - Reagent demand (e.g., limestone)
  - Oxidation air demand
  - TSS concentration and particle size

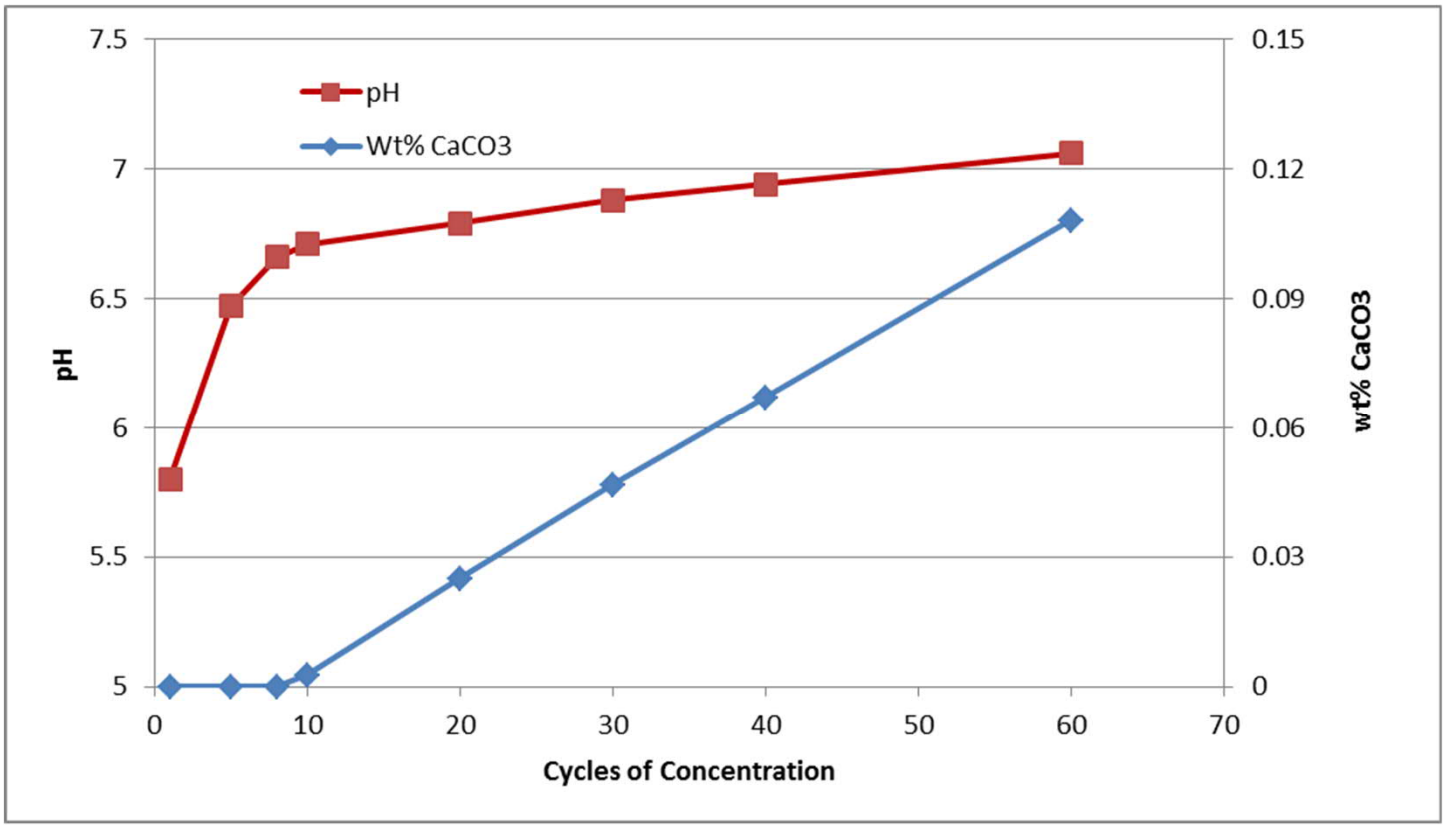
- Parameters that Increase
  - Saturated Gas & FGD Liquor Temperatures
  - pH
  - Concentration of trace metals, carbonate, TDS and chlorides



Impact on TDS & Chlorides in Wet FGD Liquor



Impact on pH & Carbonates in Wet FGD Liquor



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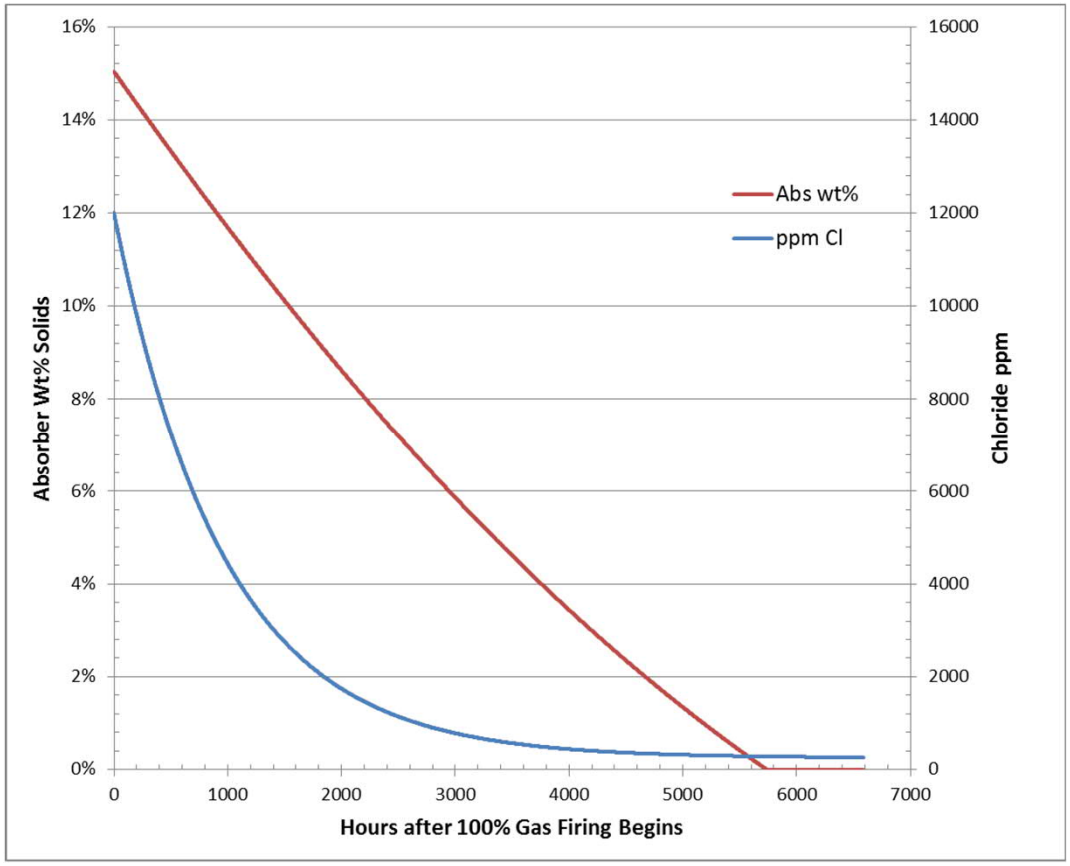
Impact on TSS in Wet FGD Liquor



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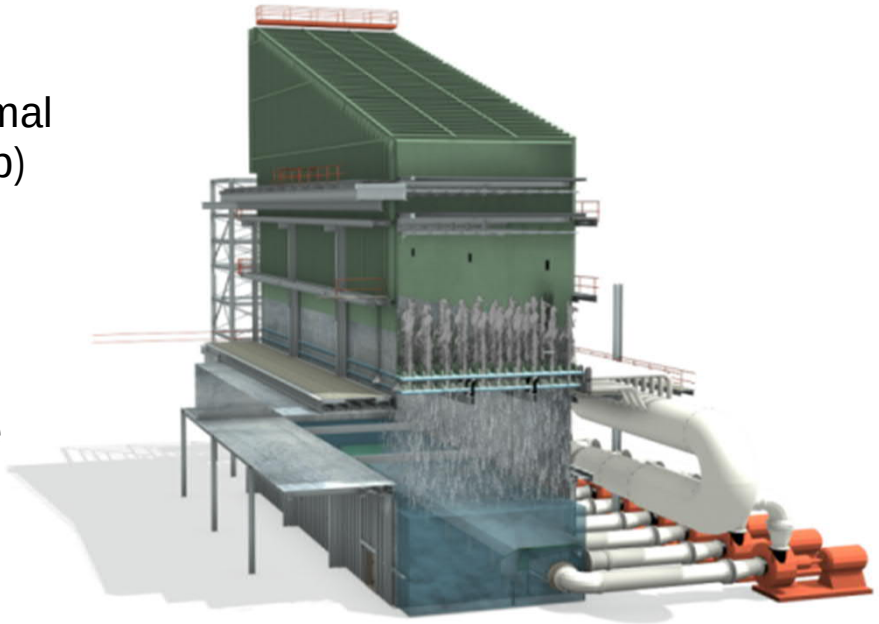
Impacts from Firing NG – SO_2 Control

Wet FGD

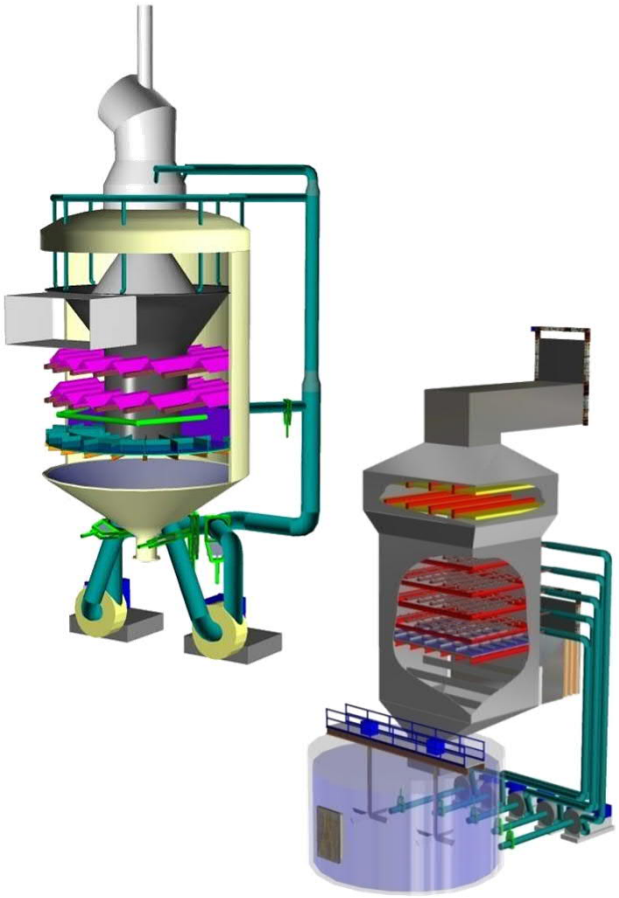
- Saturation Temperature
  - ≤ 140°F: no change
  - > 140°F: materials of construction & thermal expansion (pipe, mist eliminator, pH/r loop)
- 100% natural gas
  - Can turn down / off, but ...
    - ✓ Operate recycle pumps
    - ✓ Equilibria shift, limestone precipitate
    - ✓ Gypsum may become unsaleable
    - ✓ Residence / response time



Impacts from Firing NG – SO_2 Control

Wet FGD

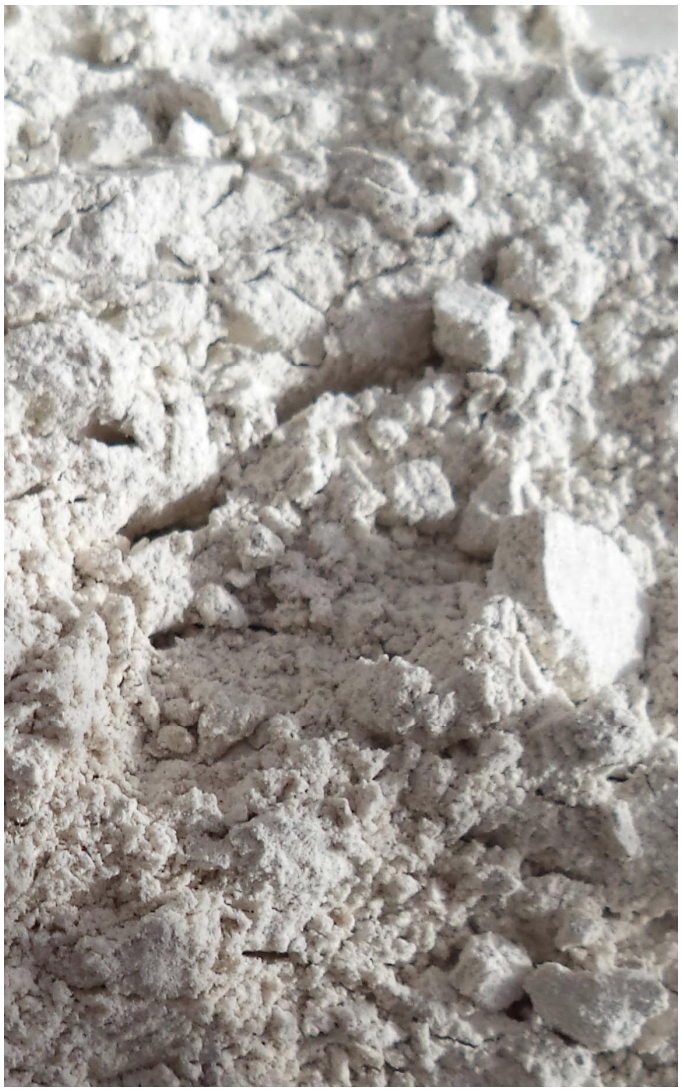
- Hg
  - Re-emissions during transitions
  - Control via ORP, oxidation air turndown
  - Re-emission additives
- WWT
  - Purge must be maintained for pH stability
  - Purge must be treated per permitted limits
  - Other chemistry changes (e.g., Cl-, temp)



Impacts from Firing NG – SO_2 Control

Wet FGD

- Gypsum
  - 50% NG: Gypsum quality should be maintained
  - 100% NG: Regrow gypsum seed crystals
- Dewatering (HC not effective @ low TSS)



Summary

For Dual Fuel Operation

- Every AQCS unit operation is impacted
- Plant Changes
  - Consider materials of construction
  - Add turndown capability
  - Add controls to maintain temperature within design limits
  - Wastewater Treatment System performance may be affected
- Operational Changes
  - Monitor/Control temperature, pH, etc. even when emissions lower
  - Add/Enhance process control for extended operating range
- Every plant is unique and requires an individual assessment to determine specific impacts and associated solutions

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