Worldwide Pollution Control Association

IL Regional Technical Seminar

September 13-15,2011

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Babcock Power Inc.




Wet FGD Designs for CSAPR

What Can we Learn from the Past Decade of High Performance Wet FGDs?

2011 WPCA IL
September 15, 2011

www.babcockpower.com

Background

- Requirements of Wet FGDs in 2000's
  - Higher Performance than 1990's
    - SO_2 Removal
  - Cost Effective
  - High Reliability
- 2nd Half Saw Further Push to Achieve Better Performance
- Upgrades to Existing Installations
  - Utilize Newer Technology
  - Reach New Performance Targets

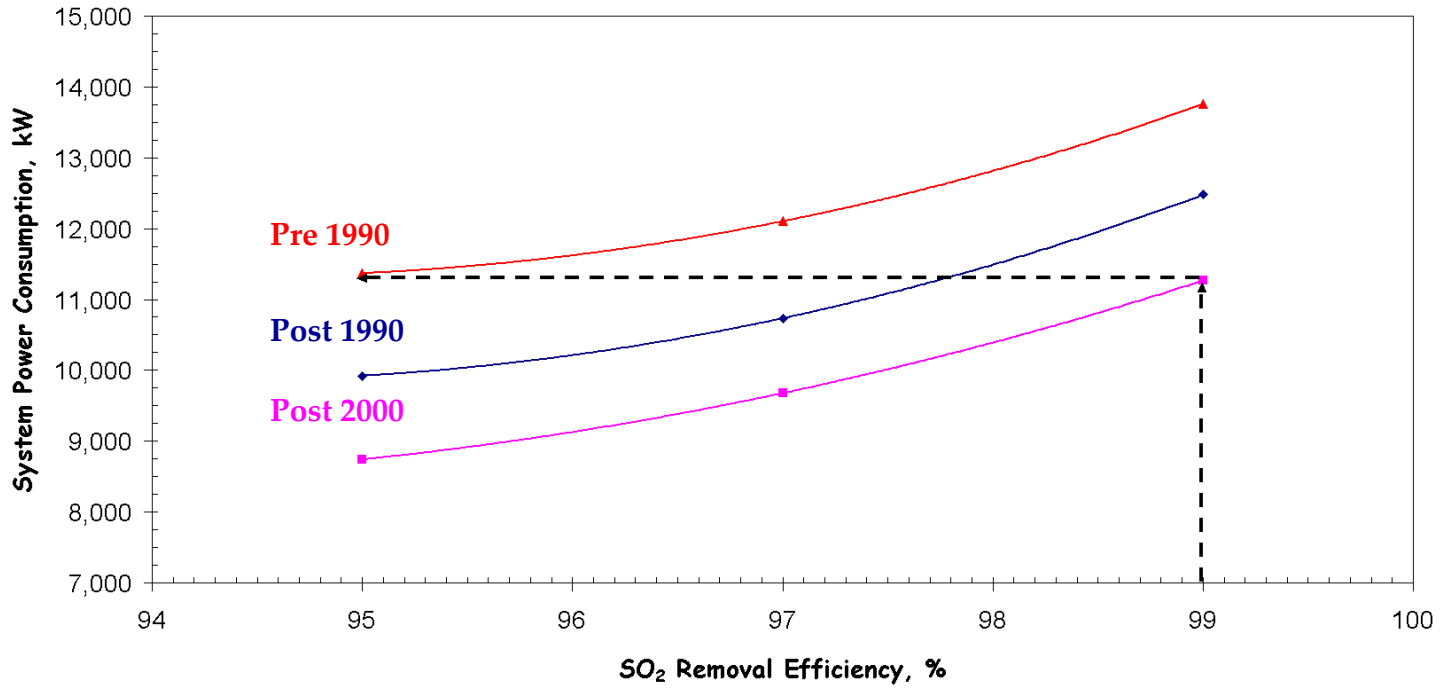
System Requirements

- SO_2 Removal
  - 97% to 99% Removal of the Inlet SO_2
- Reagent Type
  - Mostly Limestone with Some Lime Applications
- Byproduct Type
  - Large Portion Saleable Gypsum Byproduct
  - High Oxidation Specified
    - Stoichiometries 1.8 to 3.0
- Materials of Construction
  - Wide Range of Chloride Concentrations
    - Up to 50,000 ppm
  - Vessel Materials
    - Alloys
    - Lined

Technology Development

Goal:

Increase absorber performance while reducing overall system cost.



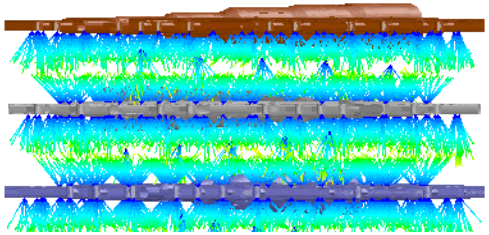
Technology Development

- SO_2 Absorption Rate Determined By Liquid Film Resistance
  - Getting SO_2 Absorbed Into the Bulk of Droplet
- Maximizing SO_2 Removal = Decreasing Liquid Film Resistance
  - Increase Absorptive Surface
    - Higher L/G
  - Increase Gas-Liquid Interaction
    - Packings, Trays, Wall Baffles, etc…
- Methods to Achieve Higher Removals Dependent on Technology Supplier

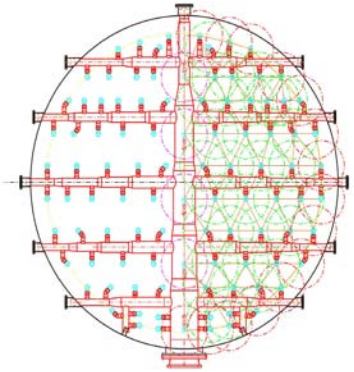
BPEI High Efficiency Absorber

Bi-Directional Spray Nozzles

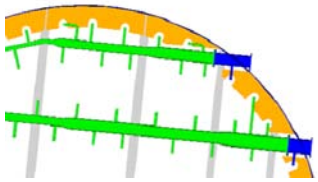
Inlet Flow Distribution



Staggered spray pattern



Tower Flow Distribution



Absorber Baffles

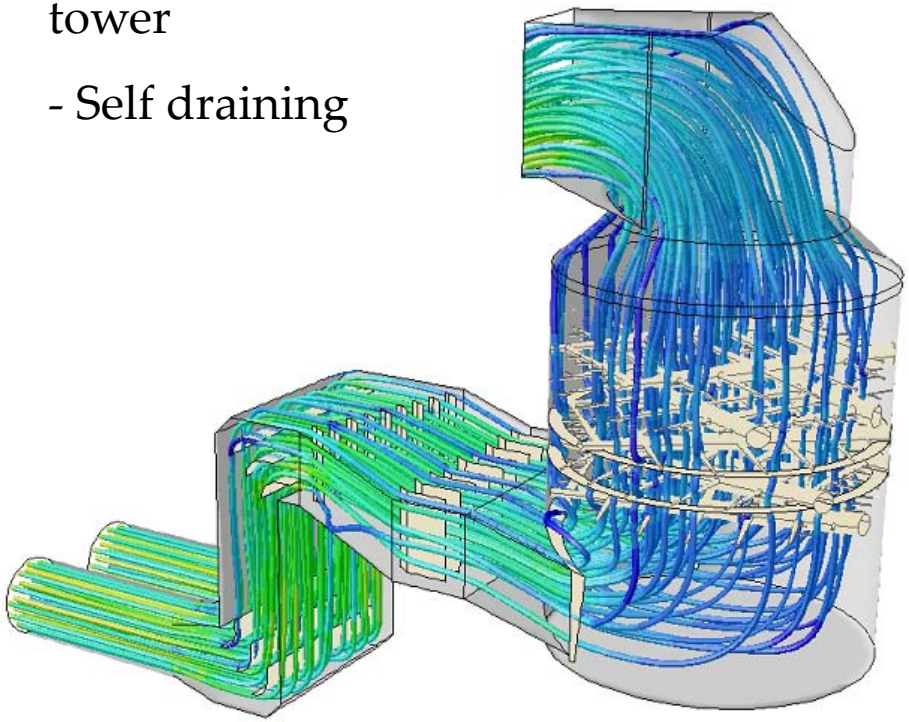
Inlet Flow Distribution

BPEI's Inlet Duct Design …

- Prevents backflow

- Provides even gas distribution across tower

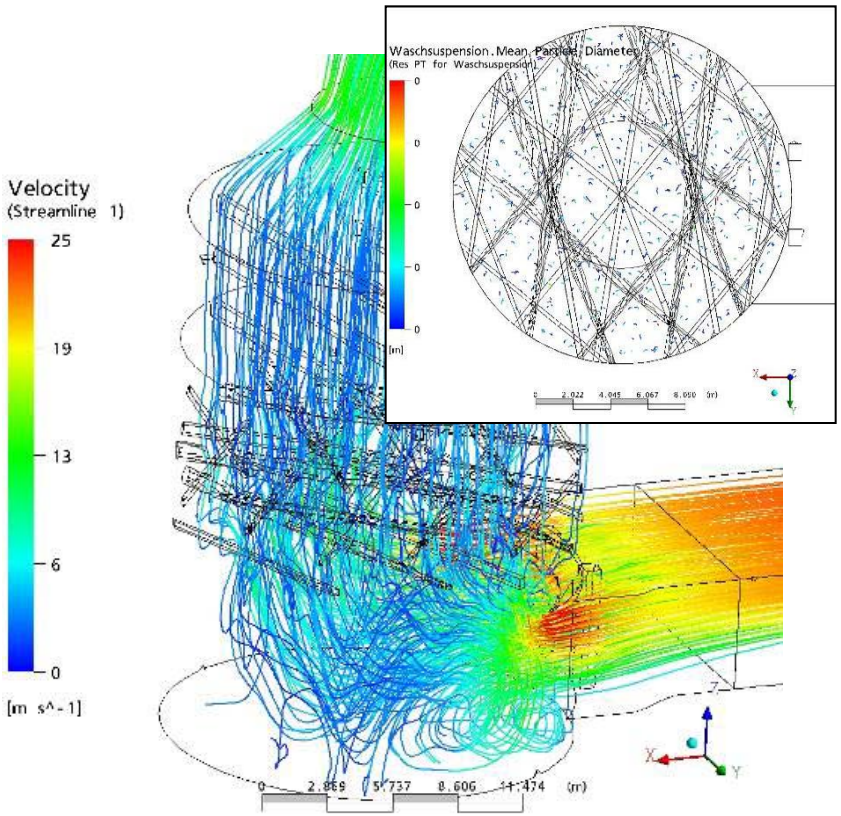
- Self draining

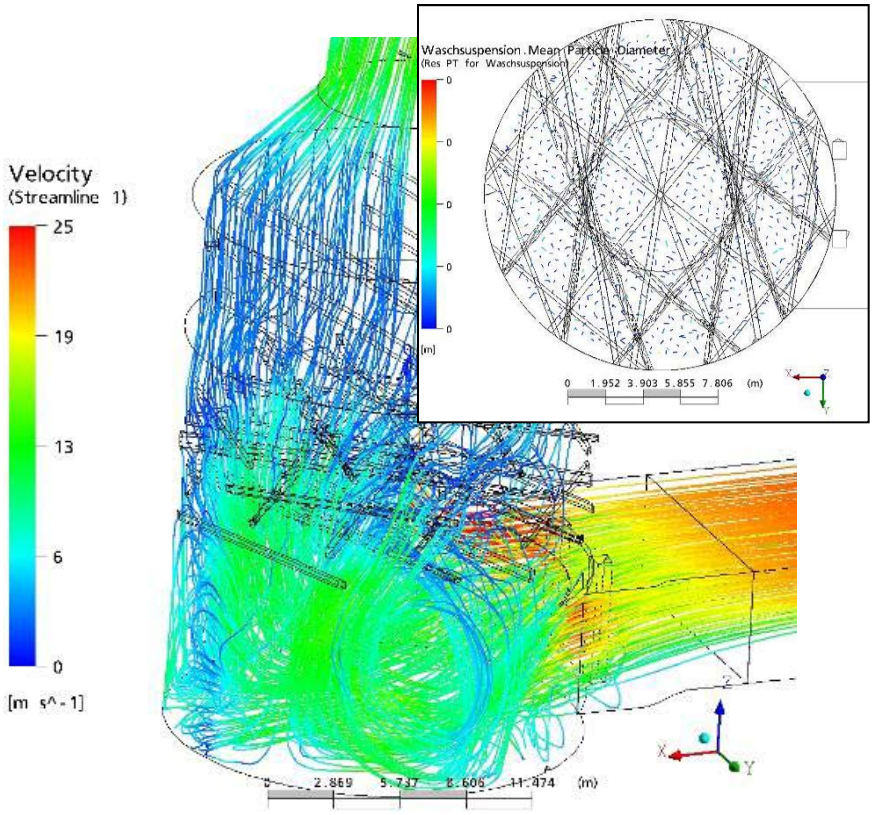


Poor inlet duct design can result in solids buildup, as well as, gas maldistribution within the spray tower.

Tower Flow Distribution

Better spray nozzle coverage …

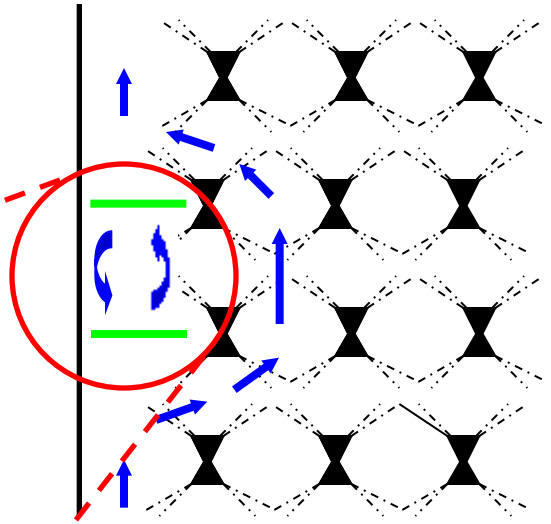


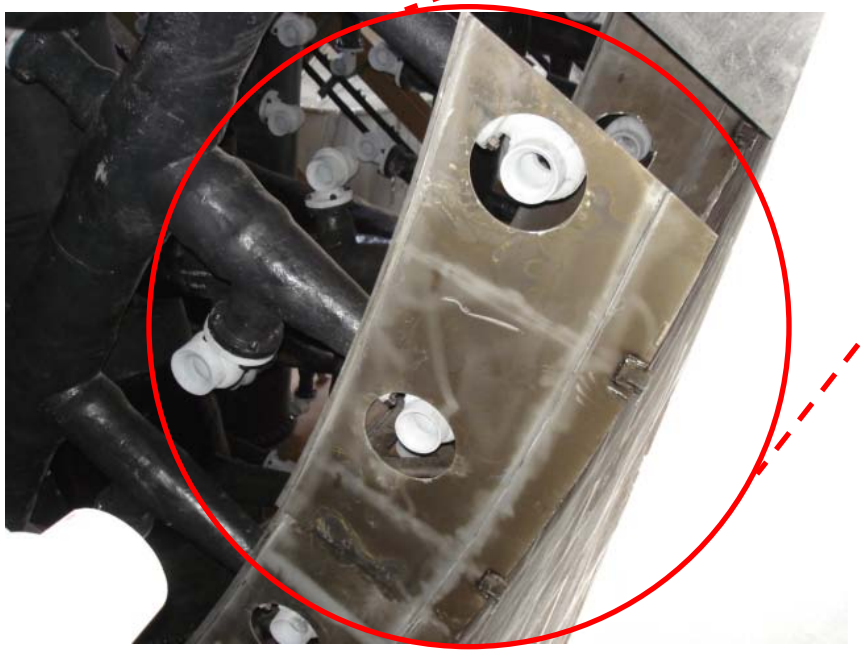


… prevents channeling and distributes gas over the entire cross section.

Eliminate Wall Sneakage

- Absorber Baffles
  - Increase SO_2 removal efficiency by up to 3%
  - Reduce L/G by greater than 20%
  - Negligible increase in gas-side pressure drop

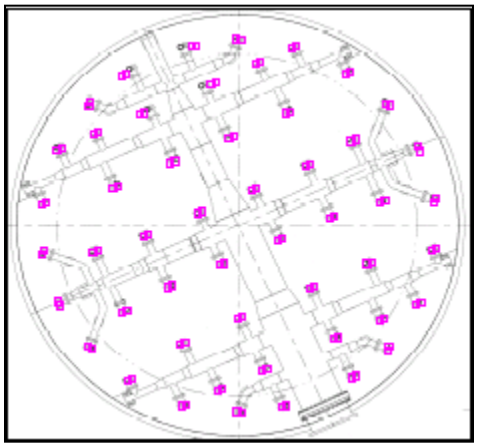




- Successfully implemented on 8,400 MW of Wet Flue Gas Desulfurization systems
  - 6,900 MW Retrofits
  - 1,500 MW Upgrades

Staggered Spray Pattern

Spray Level 1



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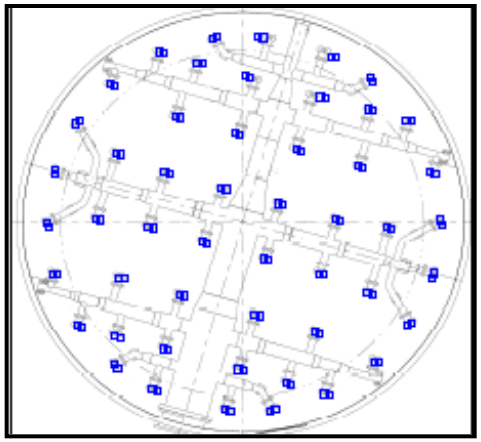
Spray Level 2



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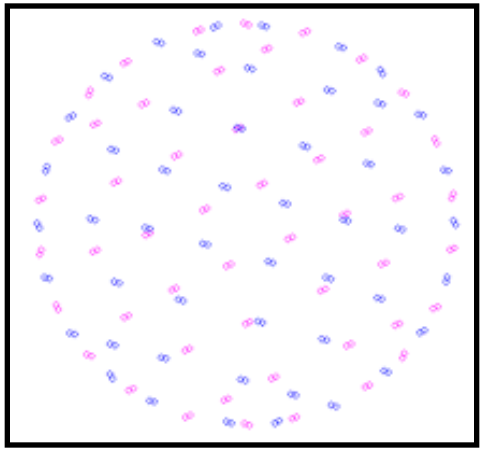
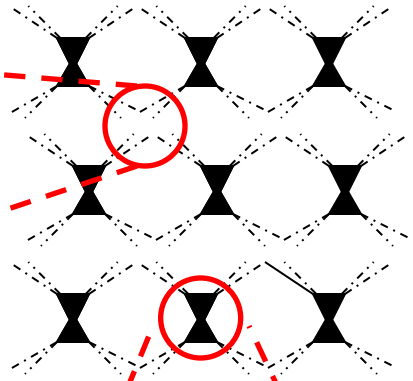
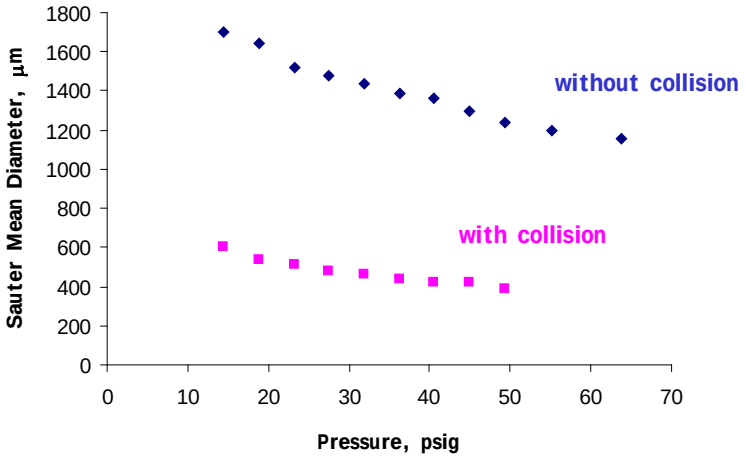
Spray Levels 1 & 2

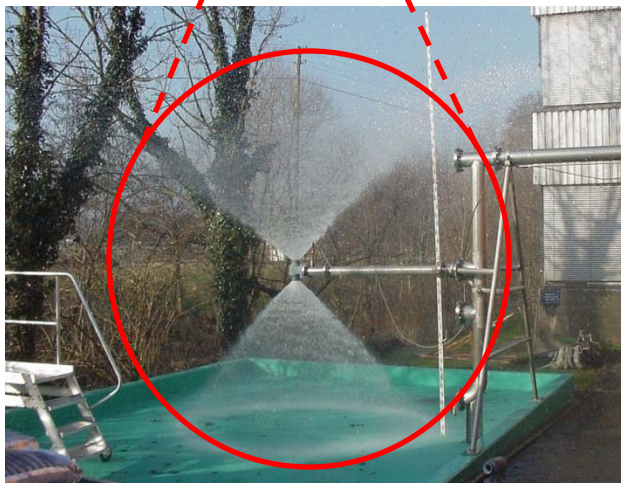


Adjacent levels are offset from one another to provide complete coverage, prevent channeling, and minimize wall sneakage.

Reduced Droplet Size

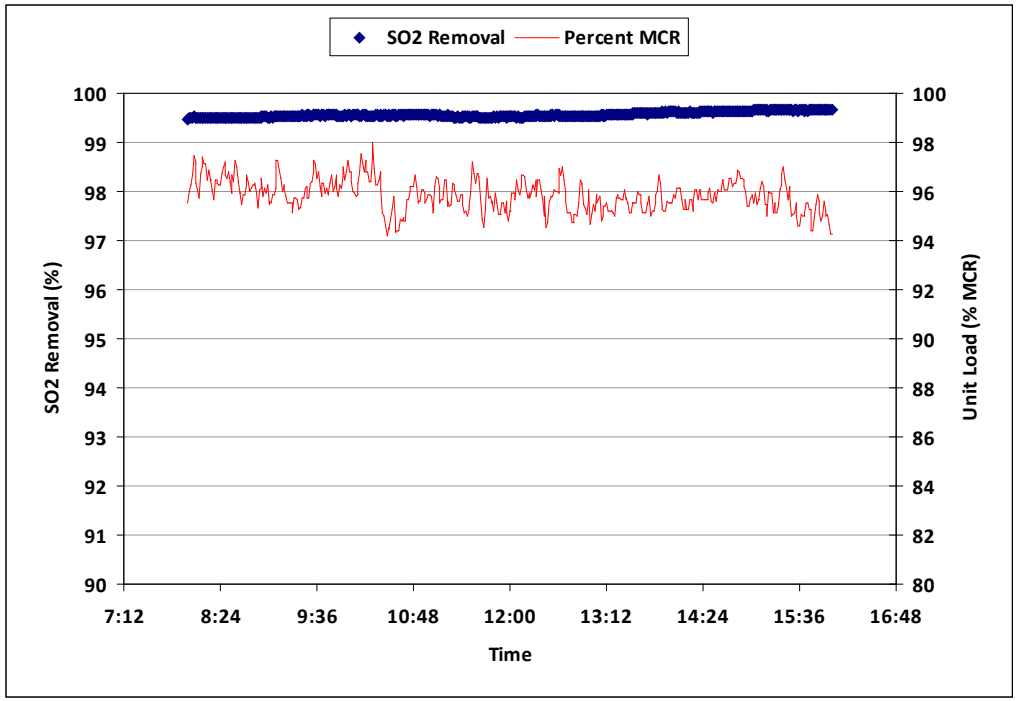






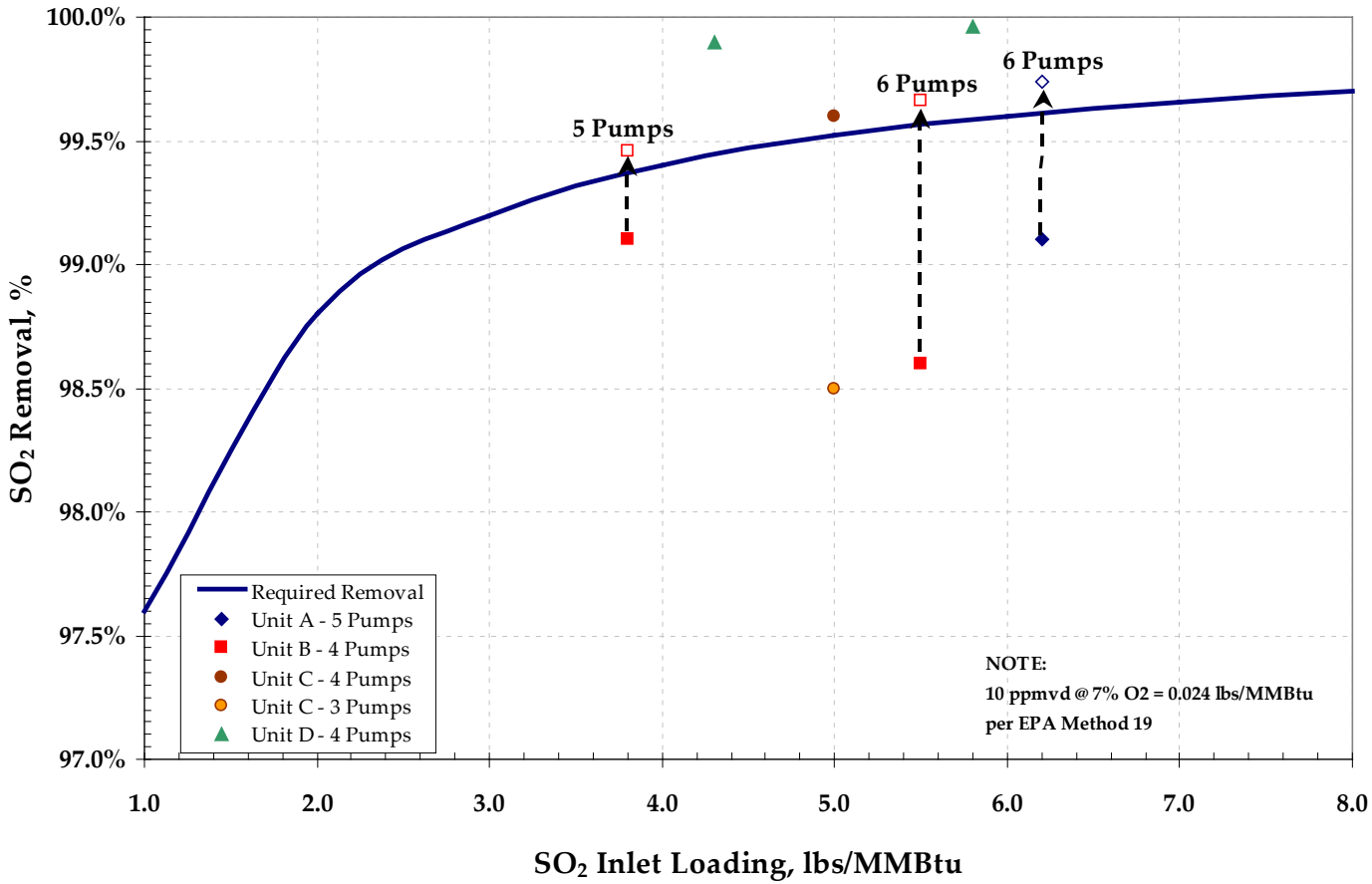
SO_2 Removal Achieved

- Highest Levels of Performance Demonstrated
  - High Removal Efficiencies (>99%)
  - Low Outlet Emissions
  - Long Periods of Operation
- Without Additives
- Normal Operation
  - No Spare Equip.
- Not Dependent on Reagent



SO_2 Removal Achieved

- Repeatable Ability to Reach Emissions Less than 10 ppm



Reagent Preparation

- Limestone Typical Reagent
- Preparation System Typically Sized for 95% passing 325 mesh
- Increased Fineness = Increased Absorber Performance
  - Depending on Differential, Could Attain Extra 1+% SO_2 Removal
  - Increased Operating Time for Mills (Higher Daily Power Consumption)

Byproduct Handling

- Production of Gypsum Preferred
- High Oxidation of Byproduct
  - Improved Mixing Technology
    - Better Air Dispersion
  - Undetectable Sulfite Levels at O/SO_2 Ratio between 2.2 and 2.4
    - Independent of Removal
- Drum Filters vs. Belt Filters
  - Drum Filters Smaller Footprint & Less Maintenance
  - Belt Filters Increased Flexibility and Better Equipped for "Closed Loop" Operation

Controls / I&C

- Emissions/Removal Control Instead of pH-Only Control
  - Increased Flexibility
  - Decreased Reagent Consumption
  - Tighter Control of Emission Limits
    - pH Feedback Maintains Chemistry within Acceptable Limits
- Emission Monitor Accuracy
  - Reliability and Accuracy at Low Emissions / High Removals
- Process Control Instrument Accuracy
  - Critical Instruments Maintained to Similar Standards

Design Considerations

- Capital Cost vs. Operating Costs
  - Savings "Up Front" vs Low O&M Costs & Future Reliability
  - "10-20 Years Down the Road" View
- Equipment Layout and Maintenance Access
  - 3D Model Review - Plant Operations and Maintenance
  - Involve Equipment Suppliers for Access Requirements
  - Frequent Access vs Intermittent Access
- Design vs Reality
  - Bigger is Not Always Better
  - Avoid Excess Margins or Margin on top of Margin
    - Maximize Turndown and Operation of Equipment
    - Minimize Parasitic Power Draw at Off-Design Conditions

Design Considerations

- Organic Acid Addition
  - Increased SO_2 Removal in Limestone Systems
  - Possible Savings of Spare Recycle Pump / Spray Level
  - Impacts to Wastewater
- Closed Loop Operation
  - Must Consider Fines as well as Chlorides
    - Impact to Vacuum Filtration
      - Size
      - Operation
  - Increased Concentrations of Other Species
    - Possible Limestone Blinding

Design Considerations

- Evaluating Inputs
  - All Potential Water Sources
    - Future Change Could Impact the Chemistry
  - Available Reagent Sources
    - Different Properties Could Impact Reagent Preparation System Performance
- Filters & Screens
  - How Clean is the Water?
    - What are the Requirements of the System?
  - Static vs Self-Cleaning Filters

Summary

- Sustainable High Removals are Achievable
  - Are the Monitors Designed to Reliably Measure it?
- Careful Considerable Given to Margins
  - Minimize Excess to Maximize Operations
- System Design Impacts to Equipment
  - What Does "Closed Loop" Really Mean?
- Initial Capital Savings ≠ Long Term Operational Savings
- Planning Upfront Pays Off Later

Thank You