REINHOLD ENVIRONMENTAL ®

2025 Reinhold/PCUG Round Table Presentation

Hosted by AEP and Buckeye Power

in The Hilton Columbus Polaris Hotel, Columbus, OH

on June 23-24, 2025

DSI Upgrades & Troubleshooting

2025 Reinhold Conference Round Table

Mark Thomas

Background & Perspective

- 35 Years of Utility Power Plant Experience
  - Cincinnati Gas & Electric > Cinergy > Duke Energy
  - Mark Thomas & Associates Consulting since 2011
- 25 Years of SO3 Mitigation Experience
- 19 Years of SCR & Catalyst Experience
- DSI System Design, Testing & Performance Evaluations, O&M
- Used Most Available Reagents
  - Calcium (Hydrated Lime, Limestone, Cao)
  - Sodium (Trona, Sodium Bicarbonate, SBS) (Wet & Dry)
  - Magnesium (Mag Hydroxide (Wet & Dry), Magnesium Sulfate (Wet)
- Various Injection Processes & Locations
  - Wet & Dry
  - Furnace to FGD Inlet
  - Coal Additives
- Work with but Independent from any Sorbent or DSI System Provider

Current DSI Systems Application

DSI has become more widespread in the last 20 years.

- Power Stations & Industrial Facilities
- Some DSI systems are approaching 20 yrs old
- Principles apply to Activated Carbon Systems
- DSI Process Development (Recent history)
- 1980s Brief Trials for SO2 at Power plants and other No Large Permanent Systems
- 2000's S03/H2SO4, Blue Plume (Sulfuric Acid Aerosol / Mist Plumes)
- 2010's – Current DSI Used for BOP Advantages & Various acid Gas Mitigation Strategies

DSI Process Basics

- DSI is Dilute Phase conveying
- Air Quality Critical
  - Convey Air for Solids Transport
  - Fluidization Air for Silo Discharge
  - Truck Unloading Air
- Convey Air Properties Important
  - Humidity
  - Velocity
  - Temperature

DSI Process Basics

- DSI is Dilute Phase conveying

Troubleshooting DSI Problems

- Troubleshooting Basics
  - What?
    - Describe the problem in detail
  - Where?
    - Specific Location of problem
    - Extent of the problem
      - Where start & end
      - Where worse & better
  - When?
    - When did the problem start?
    - When does it tend to occur?
  - How?
    - How does the problem start & develop

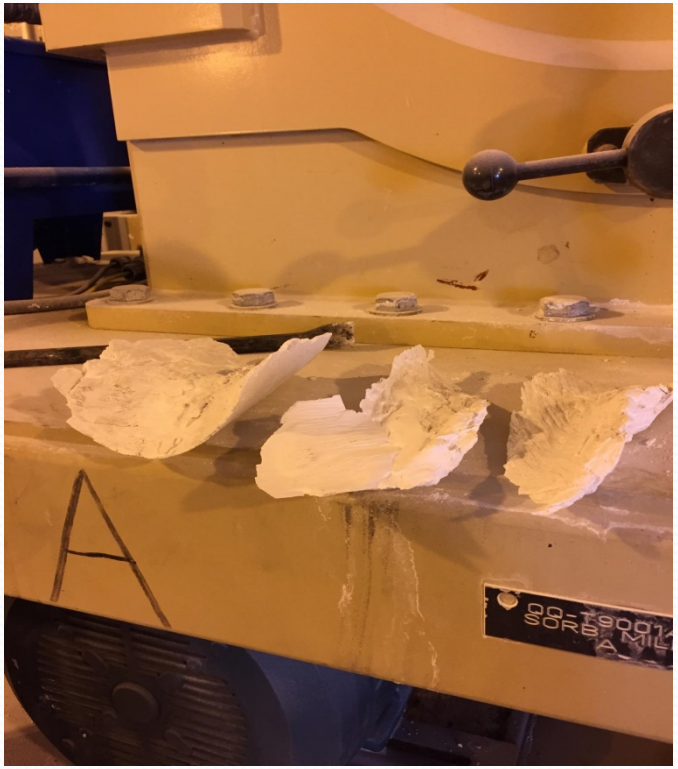
- Does the problem need to be resolved?
  - “A problem is only a problem if it’s a problem”

Troubleshooting Pluggage Problems

Specific Problem Areas

- Pickup-Tee
- Convey Lines
- Splitters
- Distribution piping
- Lances

Troubleshooting Pluggage Problems



Troubleshooting Pluggage Problems

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Troubleshooting Pluggage Problems

Typical Pluggage Causes

- Poor Convey Air Quality
  - Excess Moisture
  - Condensation
- Excess Air Velocity
- Inadequate Air Velocity
- Hi Temperature
- Flue Gas Recirculation in Hoses & Branch Piping

Troubleshooting Feed Problems

- Blocked Feed
- Inconsistent Feed
- Inaccurate Feed
- Reduced Feed

Troubleshooting System Performance Problems

- High Sorbent Usage
- Inadequate Removal Performance
- Poor Distribution or Dispersion
- Dispersion Issues

Troubleshooting Balance of Plant Impacts

- ESP Problems / Opacity
- Fly Ash Impacts
  - High LOI
  - High Calcium
  - High Sodium
- SCR Catalyst Deposits/ Pluggage
- Duct Layout
- Uneven FFDC Coverage
- AH Deposits / Pluggage

Potential Upgrades To Mitigate Problems

- Air Quality
- Lances
- Splitters
- Silo & Feed Train
- Analysis of Performance

Reasons to Consider DSI Upgrades

- Chronic O&M issues due to poor design
- Inadequate performance / inefficient
- Need to change sorbents
- Considering modified injection location for operational benefits
- Considering modified injection scheme / location for BOP benefits
- Combinations of above factors

DSI System Performance Objectives

- Minimize Sorbent Utilization
- Maximize Target Pollutant Capture
  - SO3, SO2, HCl, Hg
- Maximize Reliability & Consistent Operation
- Minimize Maintenance
- Maximize Flexibility for BOP Co-Benefits

Potential Balance Of Plant Improvements

- Maximize BOP Co-Benefits
  - SCR Min Load Operation
  - APH
    - Reduce APH Pluggage
    - Reduce APH Corrosion
    - Heat Rate Improvements
  - MATS / Hg Control
  - FFDC
    - Bag Protection
  - ESP
    - Improve Capture

Evaluating Potential DSI Upgrades

- Economic Factors
  - Cost of upgrades
    - Scope dependent
  - Operating & Maintenance cost / benefit evaluation
    - Sorbent Cost Savings
      - Improved performance
      - Changed sorbent
    - Reduced Maintenance Costs
    - BOP Impacts
      - Ash Sales Impact, etc
    - Impact on station dispatch
  - Consider Expected life of station

Evaluating Potential DSI Upgrades

- Qualitative Evaluation
  - Need for Flexibility
  - Need for Redundancy
  - Simplification
    - Helps Operations & Maintenance Personel
    - Easier to troubleshoot problems
    - Easier for new equipment owners to understand

Evaluating Potential DSI Upgrades

Consider Potential BOP Impacts

- SCR Catalyst Impacts
- APH Pluggage Potential
- Fly Ash Impacts
  - Na, Ca, Cl, C/LOI
  - Sorbent Layout in duct
- ESP
  - Ash resistivity
  - Perf Plate Pluggage (Trona)
  - Uneven Sorbent Loading
- FFDC
  - Uneven Sorbent loading, unprotected areas

Evaluating Potential DSI Upgrades

Need Cost Effective New & Retrofit Solutions

- Cost Savings Always Desirable
- Can use cost savings to add redundancy / flexibility
- Can use cost savings to improve other plant systems
- Some plants have nearer term closure dates

Evaluating Potential DSI Upgrades

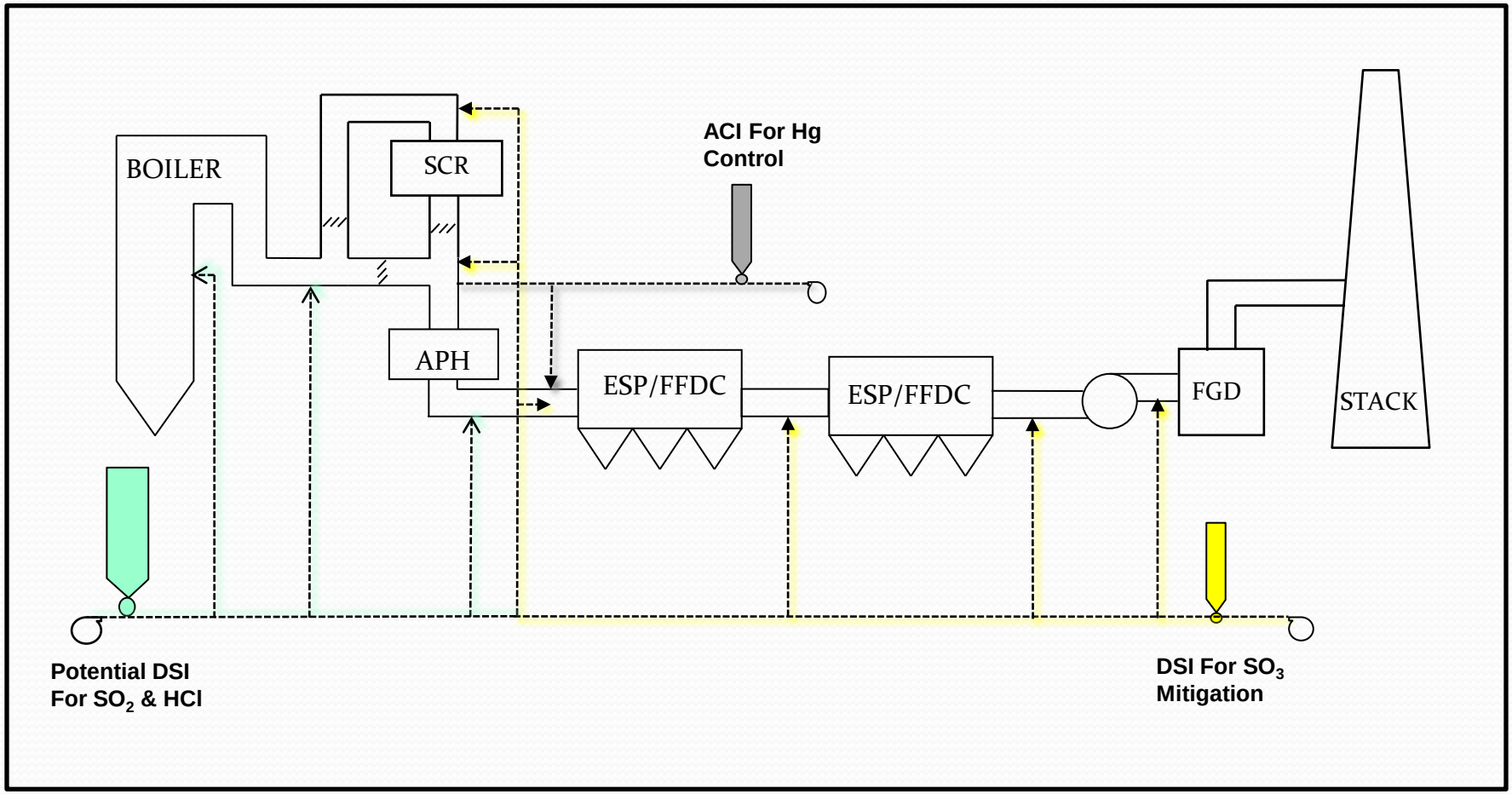
How to achieve reliable upgrades while saving costs?

- Determine what part(s) of the system need to be retrofitted
  - Requires a clear understanding of current problems
    - Examples
      - Is Pluggage an air quality problem or a system design problem?
      - Is poor performance due to the injection location or poor dispersion.
  - Requires a clear understanding of desired objectives and expected results
    - May require some testing to quantify or prove concept

Evaluating Potential DSI Upgrades

- How to achieve reliable upgrades while saving costs?
  - Determine if existing Equipment be re-used or repurposed?
    - Silo / Storage
    - Feed system
    - Convey Air system
    - Sorbent convey & splitting
    - Injection lances (or lanceless injectors)
    - Dispersion & mixing
    - Injection location

POTENTIAL DSI & ACI INJECTION LOCATIONS



Examples of Cost Effective DSI Retrofits

- Improved Feed System
- Distribution & Splitting for Added Injection Locations
- Improved Dispersion & Mixing
- Convey & Unloading Air Quality

This presentation will focus on options that work and are cost effective.

DSI FEED SYSTEMS – STANDARD DESIGN

DSI FEED SYSTEMS - SIMPLIFIED

- Single Feeder
- Vent to Top of Silo – No Cartridge Filters
- No Aeration in Weigh Bin

DSI FEED SYSTEM IMPROVEMENTS

- Longer Fill Cycles
- Smoother LIW Signal
  - No Interference from Bag cleaning and blinding
  - Vent line maintains constant pressure
- Reduced Maintenance on Rotary Airlocks
- Self Clearing vent line
- Hose Connections for ease of cleaning and inspections

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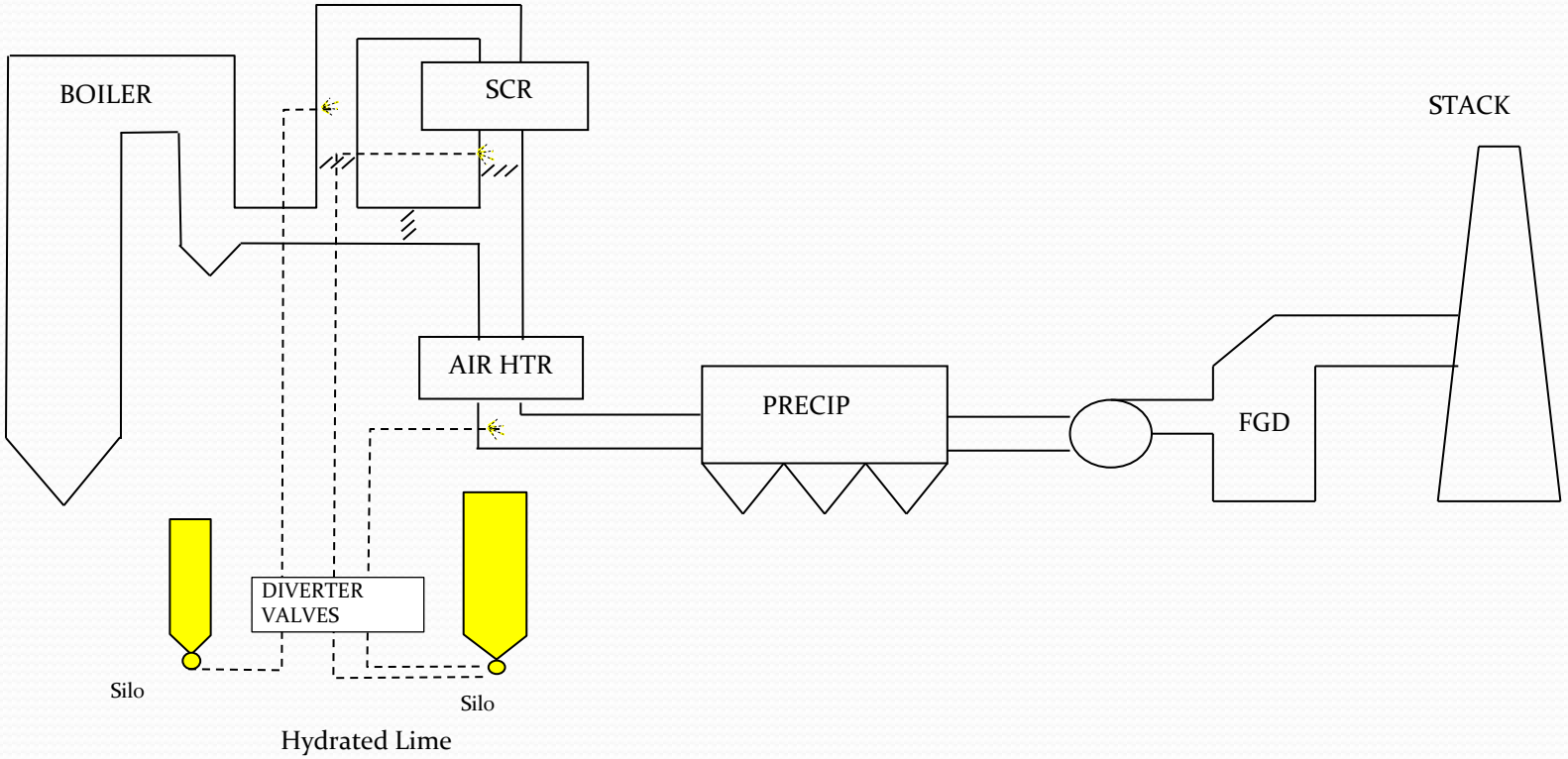
DSI CONVEY & SPLITTER SYSTEMS

- Multi Point Injection
  - Drives the need for cost effective but high performing lances and feed systems



DSI System Convey System Retrofits

- Use of Diverter Valves to feed alternate Injection Sites
  - Can be swap quickly to alternate injection grid location
  - Can be used to achieve redundancy for more critical application

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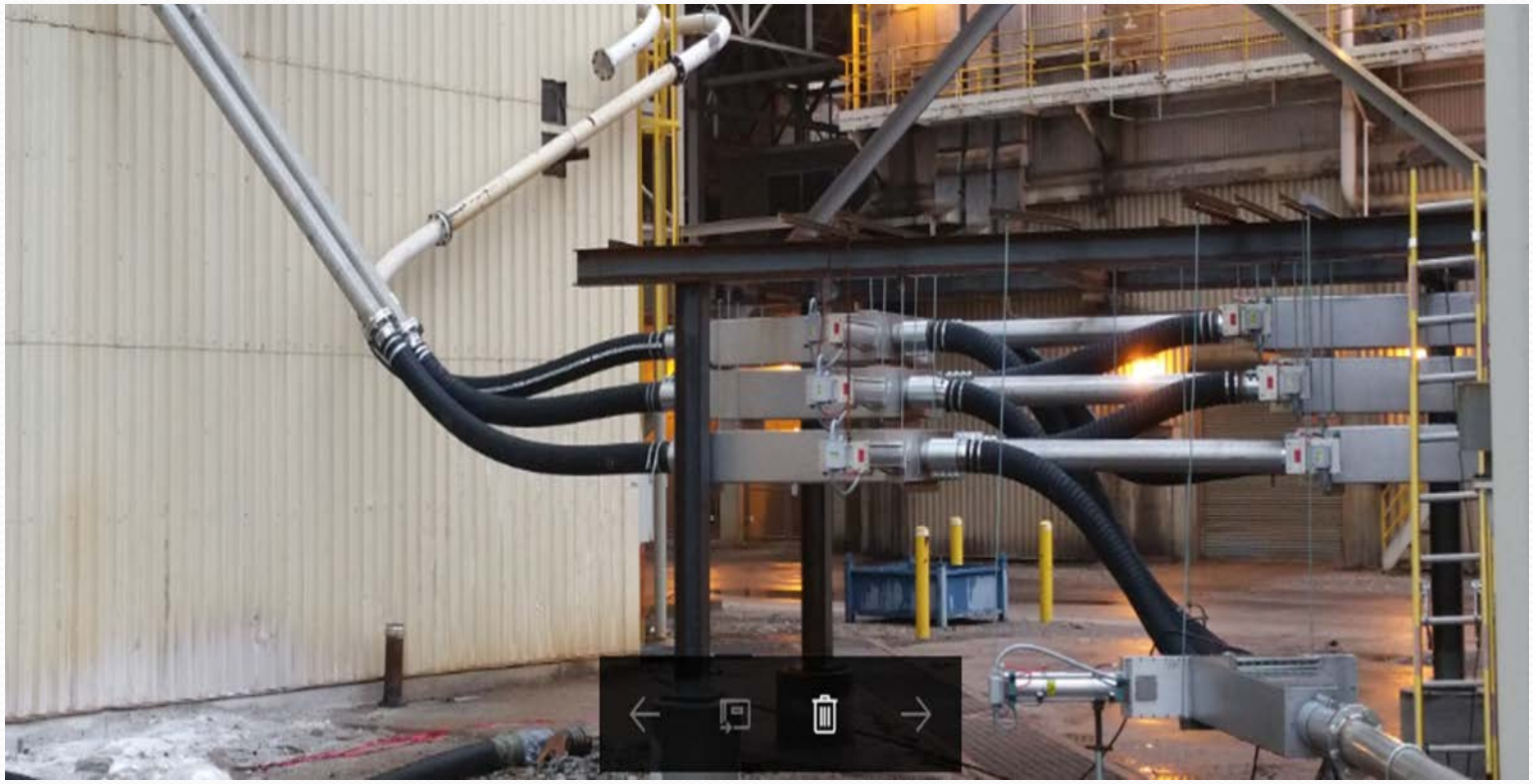


SPLITTER DESIGN WITH INTEGRAL SIGHT GLASSES

- Cost Effective
- Provides ability to easily see relative flows to each lance
- Splitter body less prone to surface rust & product clinging
- Easy to clean and replace sight glaass

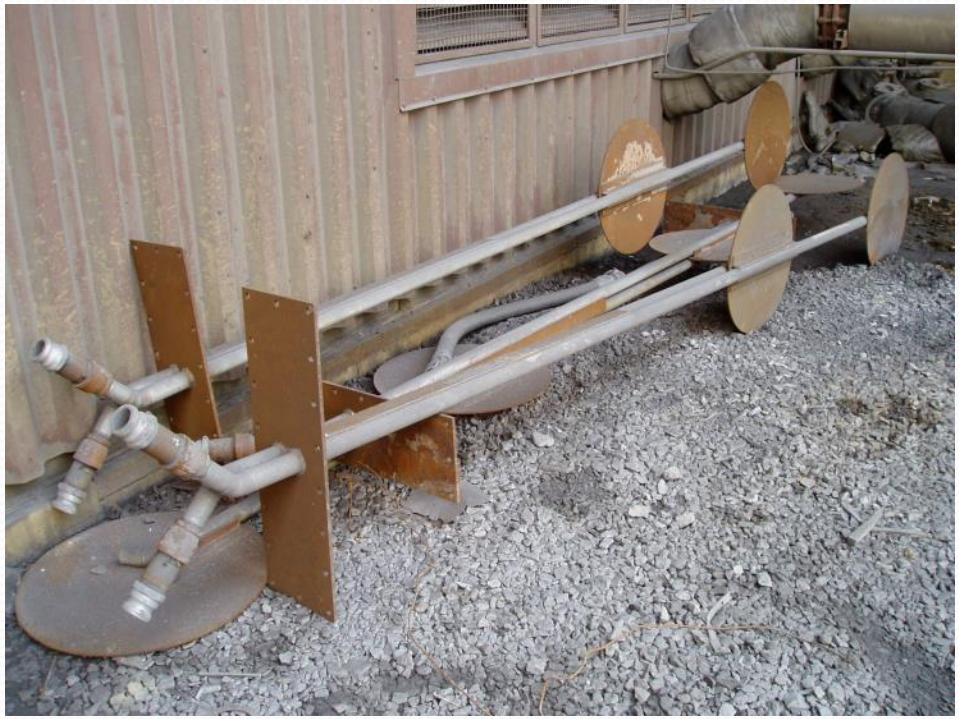
Typical Industry Standard Lance Design

2007 Lime Lances

2012 Trona Lances

Additional Early Generation Advanced Lances

2004 Trona & Lime Lances



2005 Trona Lances

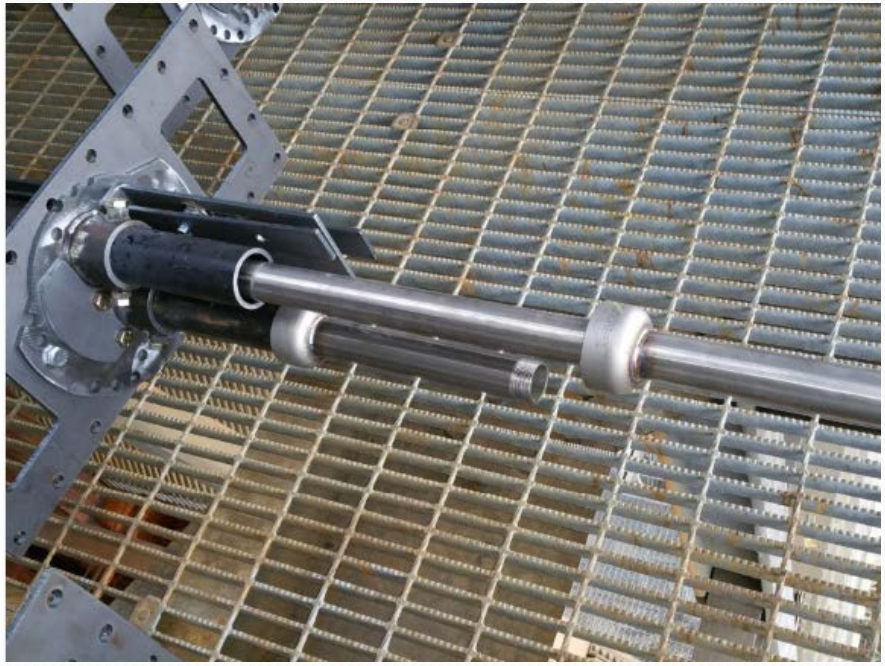
Continued Development of Advanced Lances

2016 Lances

2017 Lances

Continued Development of Advanced Lances

2018 DSI Lances – Adjustable Mix Plates & View Ports



Note: Lance removal requires no tools

Continued Development of Advanced Lances

2020 – Current Lances – Adjustable Mix Plates & View Ports

Note: Lance removal requires no tools

Benefits from Advanced Lance Designs

- Significantly Improved Dispersion
  - Currently up to 42 " Diameter Mixing Plates
- Effective at Very Reasonable Fabrication Cost
- Easy go install thru rectangular ports
  - Existing ports can be used but require internal mixer attachment
- Can eliminate the need for internal scaffolding for installation or maintenance or modifications.
- Designed to be easily modified for future improvements
- Can install multiple lances in same port at different elevations
- Can be installed in any orientation

Benefits from Advanced Lance Designs

- Designs can be customized for specific applications
  - Plate Tilt & (Rotation) Adjustable from duct exterior or interior
    - Can evaluate performance realtime
    - Can evaluate pressure drop
    - Can adjust to minimize erosion patterns on lances or on erosion induced by mixing plates
- Maintenance for lance checks drastically simplified.
  - Lance tube removal requires no tools
  - Can be removed and replaced in a few minutes
  - Lance tube protected from corrosion and excessive heat

Convey Air Upgrades - Dehumidifiers

AIR QUALITY IMPROVEMENTS USING DEHUMIDIFICATION SYSTEM

1084 SCFM
82 F
130 Gr/Lb
167 Gr @Sat

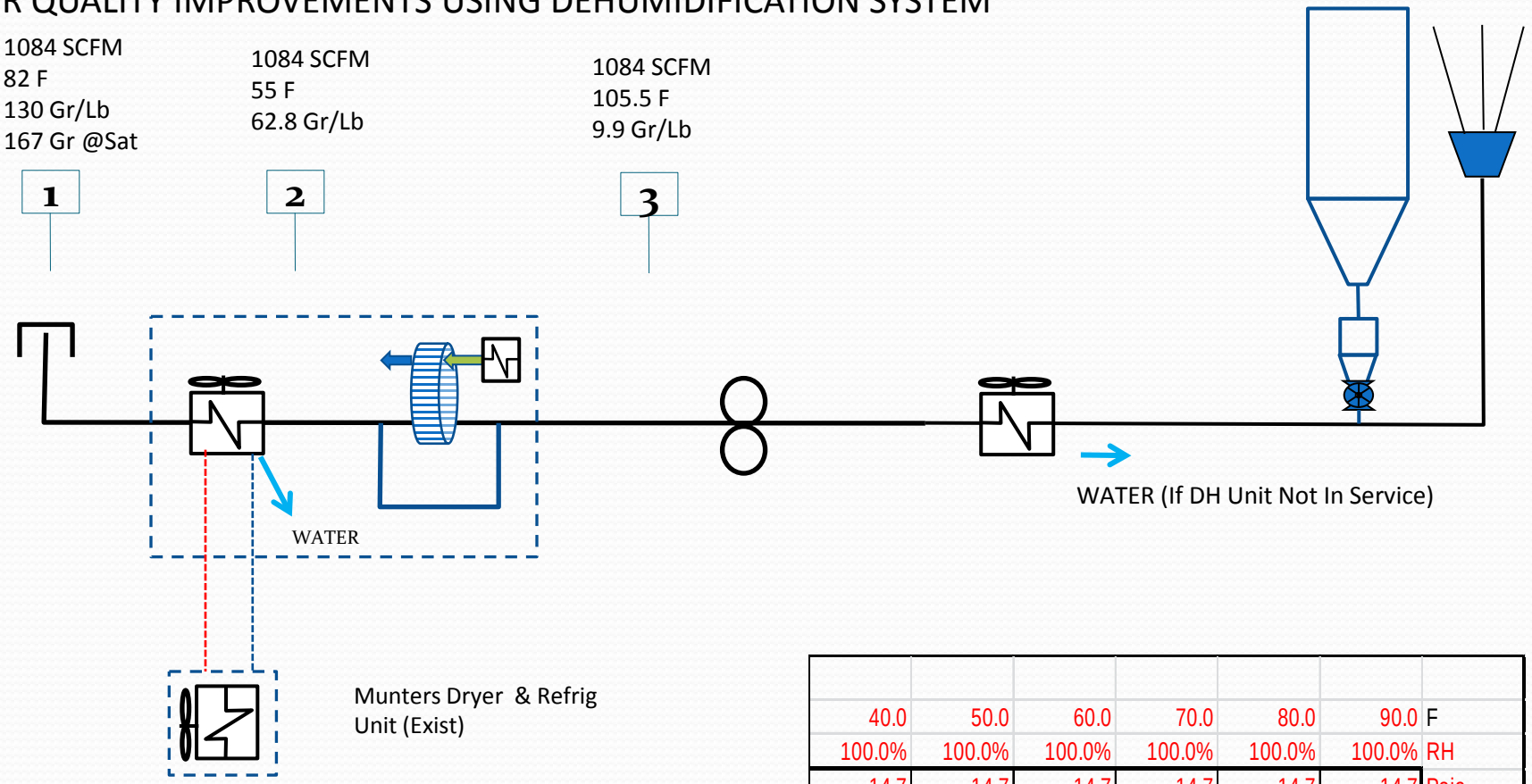
1

1084 SCFM
55 F
62.8 Gr/Lb

2

1084 SCFM
105.5 F
9.9 Gr/Lb

3



Munters Dryer & Refrig Unit (Exist)

40.0	50.0	60.0	70.0	80.0	90.0	F
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	RH
14.7	14.7	14.7	14.7	14.7	14.7	Psia
36	53	77	110	156	217	Gr/Lb
23.7	23.7	23.7	23.7	23.7	23.7	Psia
22	33	48	68	95	132	Gr/Lb

Evaluating Potential DSI Upgrades - Summary

- Thorough assessments important
- Know your current and possible future objectives
- Consider re-use of existing equipment
- Integrated approach critical
- Help available from industry experts

QUESTIONS?