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SO2 – Control Processes

Presented By Will Goss

Prepared 7/21/03

Wet Scrubbing – SO2 Control

- Early Technologies (Wet)
  - Pulp & Paper (Caustic)
  - Boilers (Limestone)
  - Boilers (Soda Ash)
- Later Technologies
  - Spray Dryers (Semi-Dry)
  - Reactors (Semi-Dry)
  - Flash Dryers (Semi-Dry)

Wet Scrubbing Systems

Limestone Chemistry (Wet Systems)

$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$ (aq)

$Ca(HCO_3)_2 + 2SO_2 \rightarrow Ca(HSO_3)_2 + 2CO_2$

$Ca(HSO_3)_2 + O_2 \rightarrow CaSO_4 + H_2SO_4$ (oxidation)

$H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + CO_2 + H_2O$

$CaSO_4 + 2H_2O \rightarrow CaSO_4\text{-}2H_2O$ (gypsum crystallization)

Small Chemical Plant

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Semi-Dry – Scrubbing Advances

1978 First Spray Dryers (Disks) Appear

1980 First Nozzle Spray Dryers

1982 Spray Dryer (disk) with Recycle

1988 First Reactors (Incinerators)

1990 DOE Clean Coal Projects

1992 EPRI Cost Study of Processes

2002 Patents covering Flash Dryer

Semi-Dry Chemistry

(slaking pebble lime)

$CaO + H_2O$ ------> $Ca(OH)_2$

$Ca(OH)_2 + SO_2$ ------> $CaSO_3 \bullet \frac{1}{2} H_2O + \frac{1}{2} H_2O$

$Ca(OH)_2 + SO_3 + H_2O$ ------> $CaSO_4 \bullet 2H_2O$

Problems

- Build-Up
- 10-15 seconds residence time
- Poor Drying

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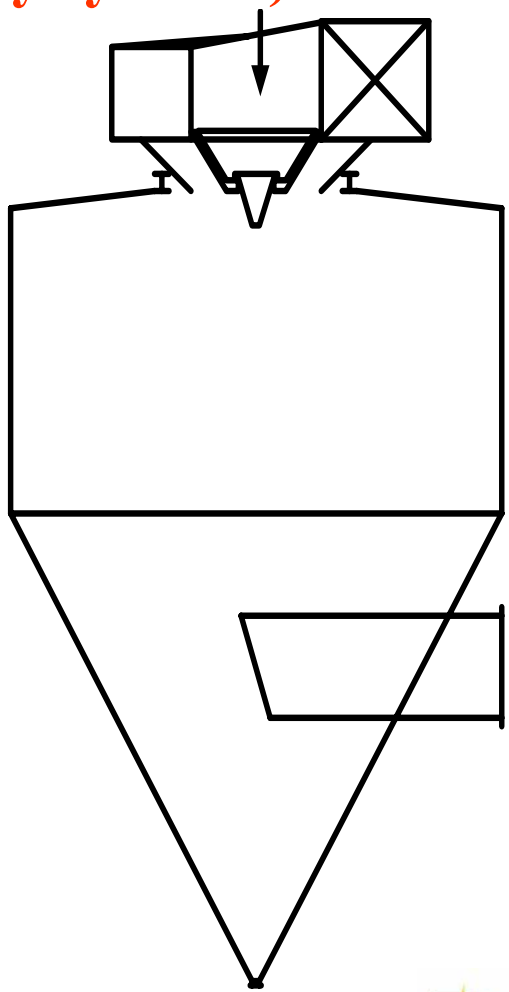
Wheel Type Semi-Dry – Scrubber

(rotary atomized – spray slurry systems)



Problems

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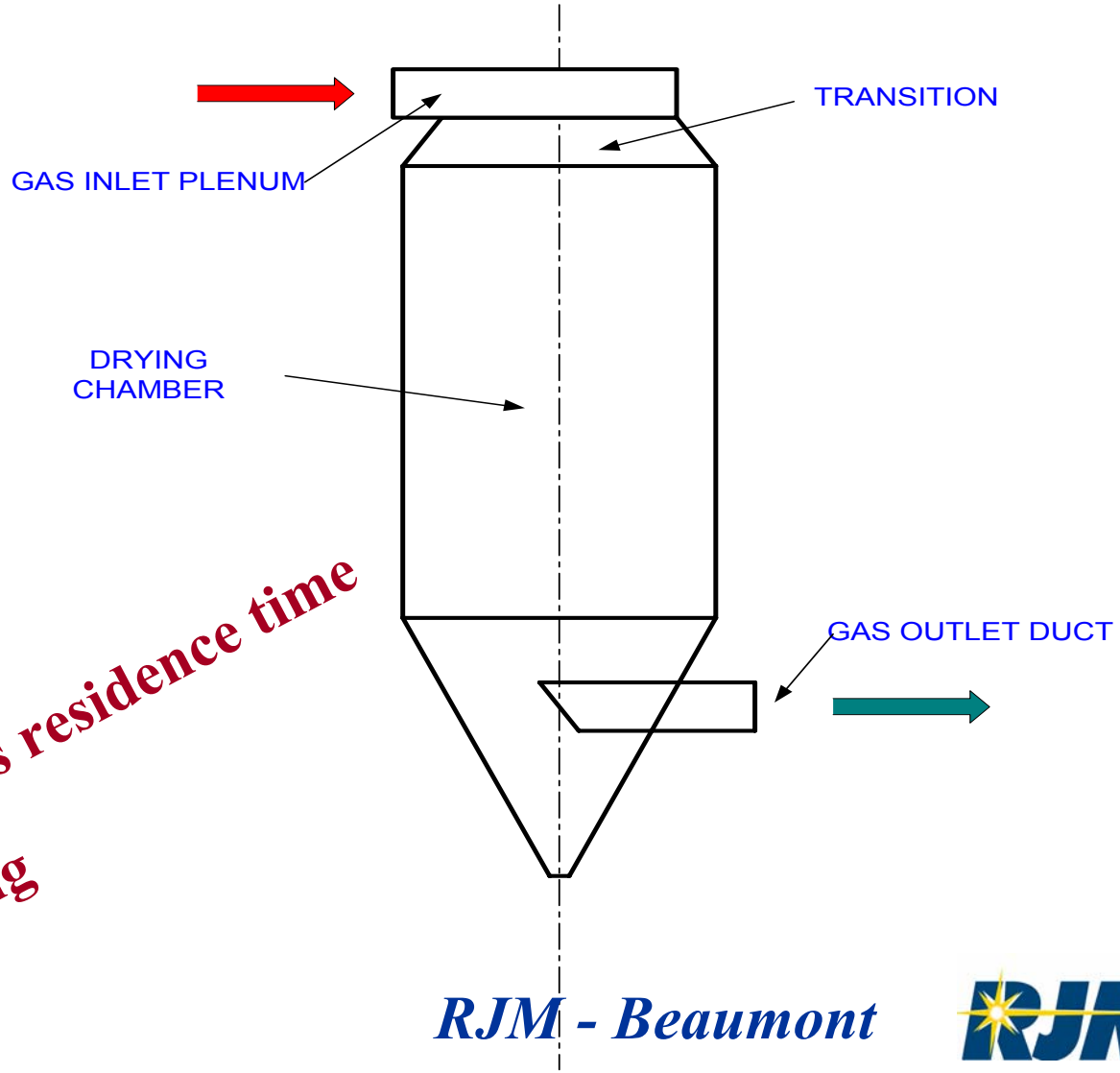
Nozzle Type Semi-Dry Scrubber



Problems

- Build-Up
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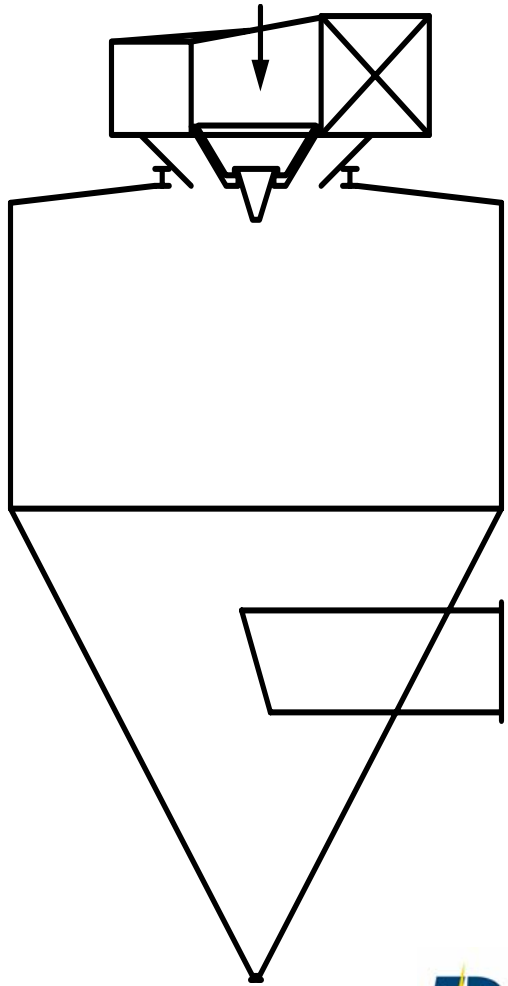
Wheel Type Semi-Dry – Scrubber

(rotary atomized – spray slurry systems)

Recycle Added

- Able to improve efficiencies
- Able to improve utilization



Problems

- Build-Up
- 10-15 seconds time
- Poor Drying
- Wear

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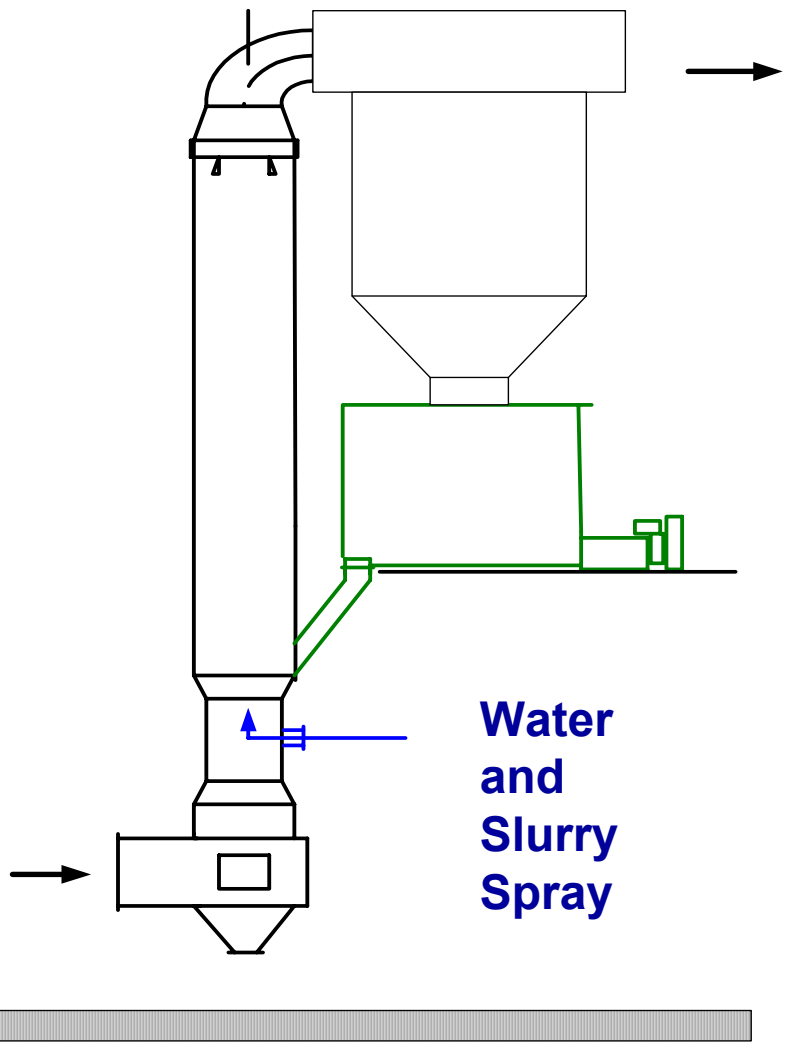
Reactor Type



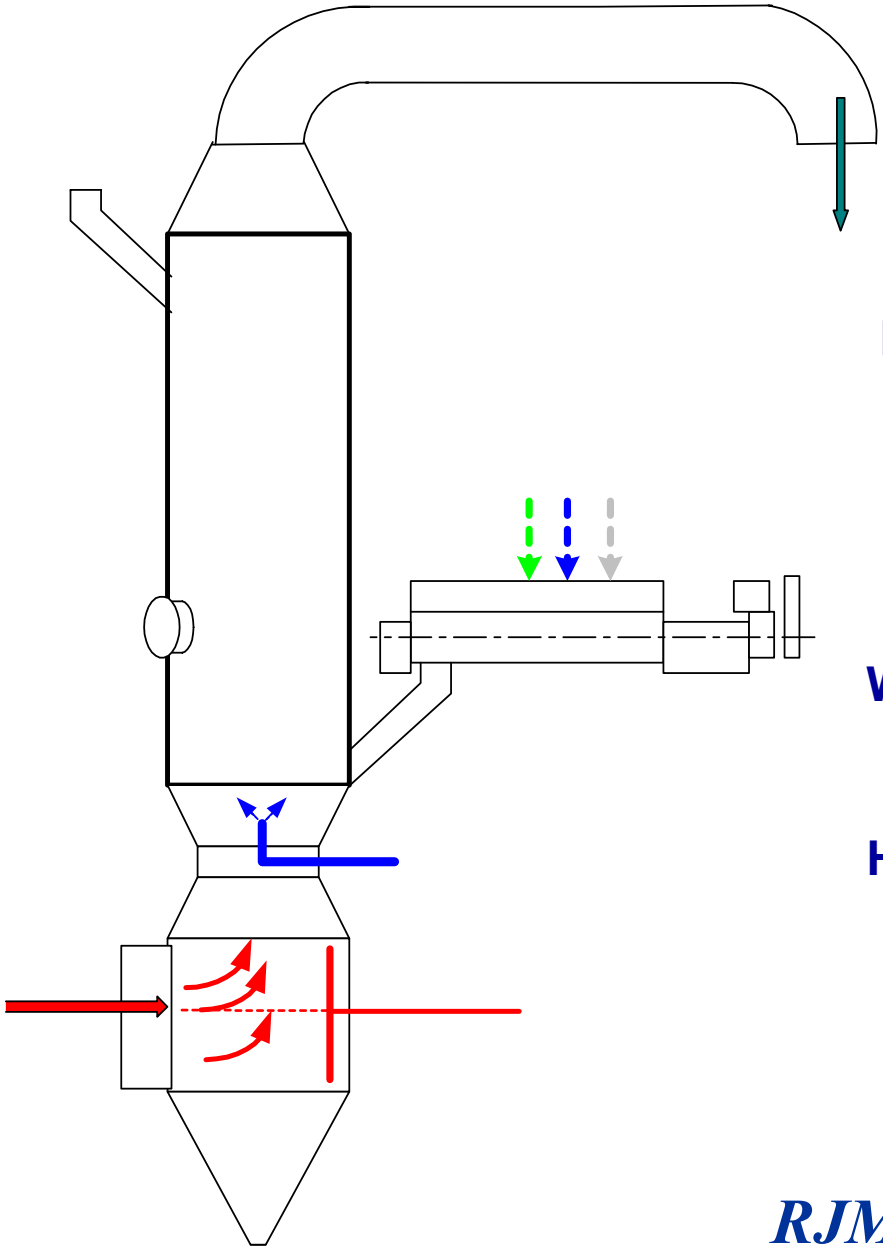
Utilizes Cyclone above recycle box.

Problems

- Pressure Drop

-HP Recycle Box

-Efficiency



Flash Drying Loop

Rapid Absorption Process

Evaporative Cooler

Modular for High Turndown

Slurry added at Mixer

Water Added at Mixer

Recycle Added at Mixer

Waste Liquid Added at Mixer

Secondary Additive Port

High Temperature Discharge

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Photo of Semi-Dry Stack at 165 F

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What is **Multi-Pollutant** Control

- Control for Combustion Processes – Typically Boilers,
- Where the System is Selected to Control more than one Pollutant in a Common Vessel,
- Using a Minimum Number of Components,
- That Include the Flexibility to meet Future Requirements,
- In a Cost Effective Design,
- With no Liquid Disposal and,
- Dry Safe Disposal Material

What to Control?

- Temperature
- H2SO4
- HCl
- SO3
- SO2
- Mercury
- Other Toxic Metals (NESHAP)
- Ash
- Fine Particulate

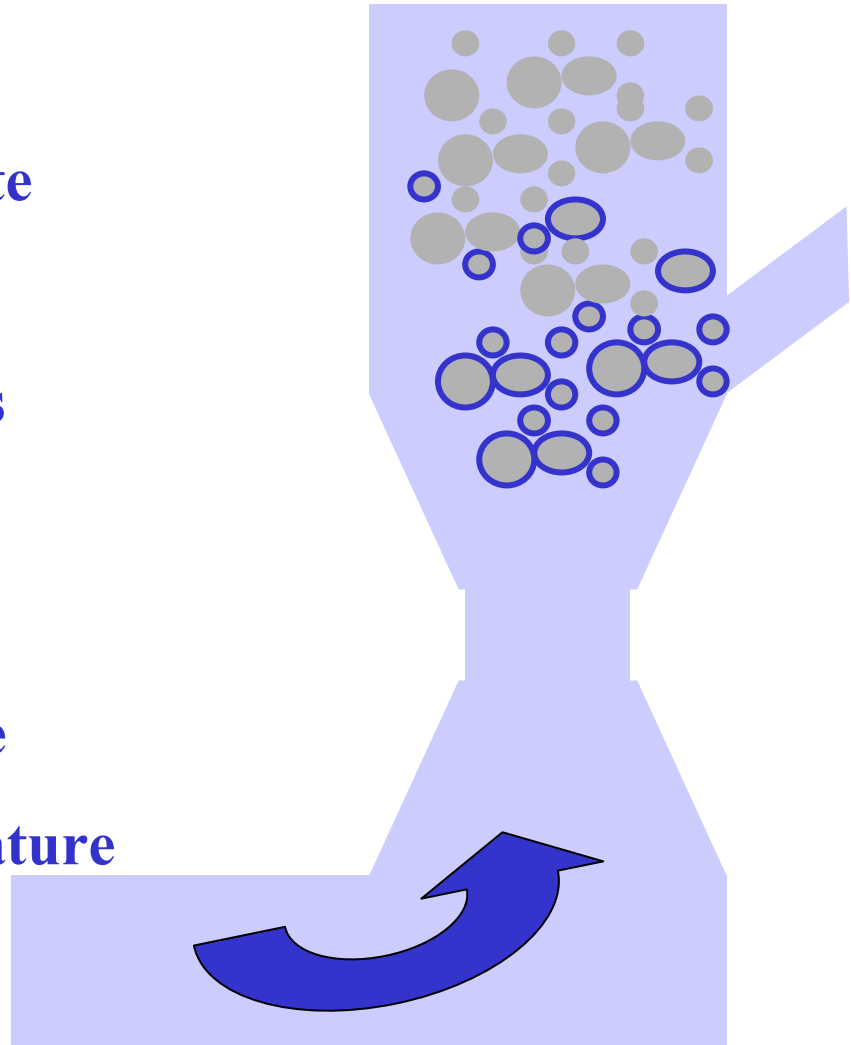
Flash Drying RAP Reactor

Maximize Surface Area by

* **Increasing Recycle Rate**
* **Recycling Fines**

The Finely Coated Particles

* **Improved Cooling**
* **Improved Reaction**
* **Decreased Drying Time**
* **Higher Outlet Temperature**



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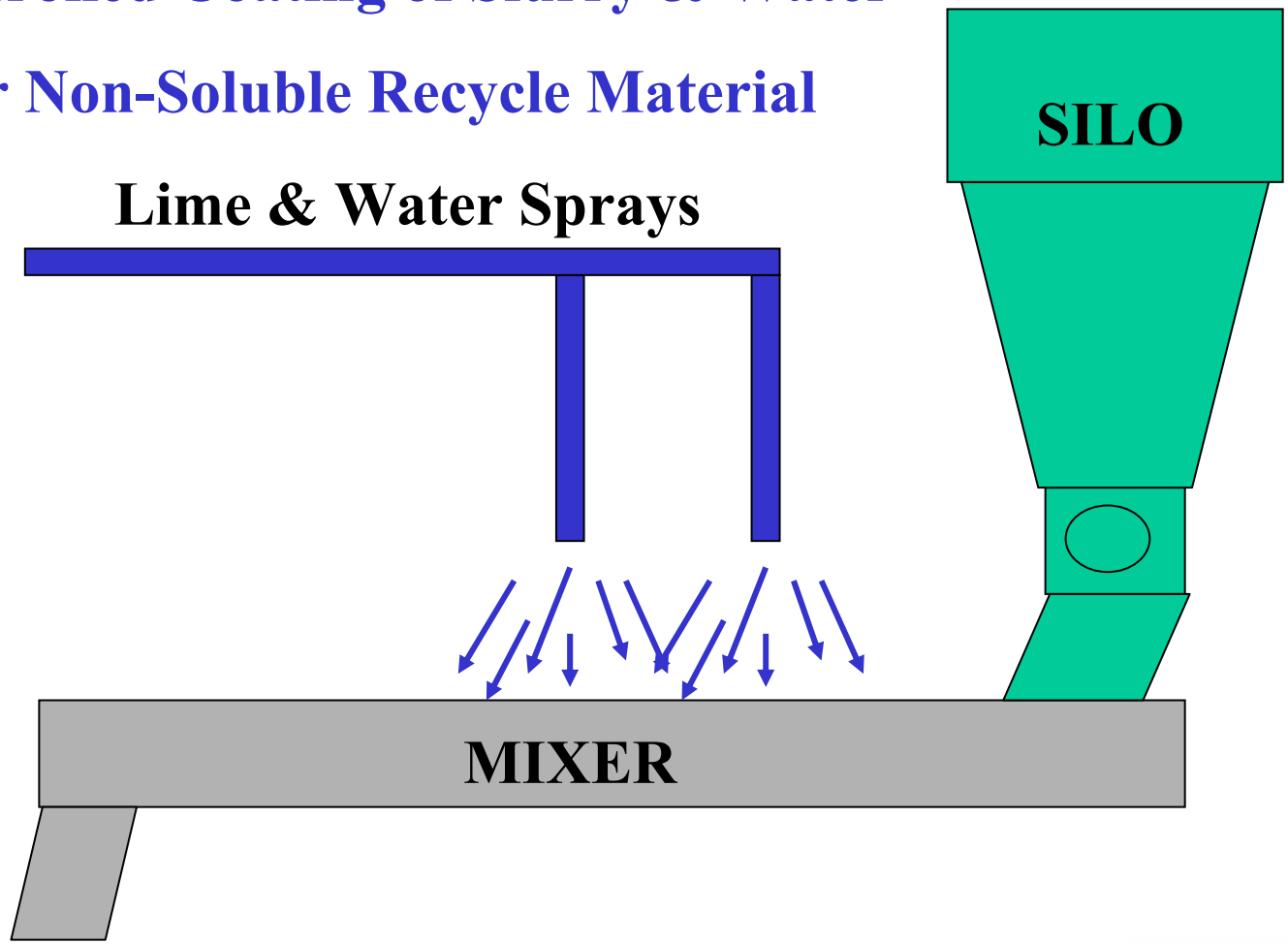
Flash Drying Wetting System

Controlled Coating of Slurry & Water

Over Non-Soluble Recycle Material



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Mixer

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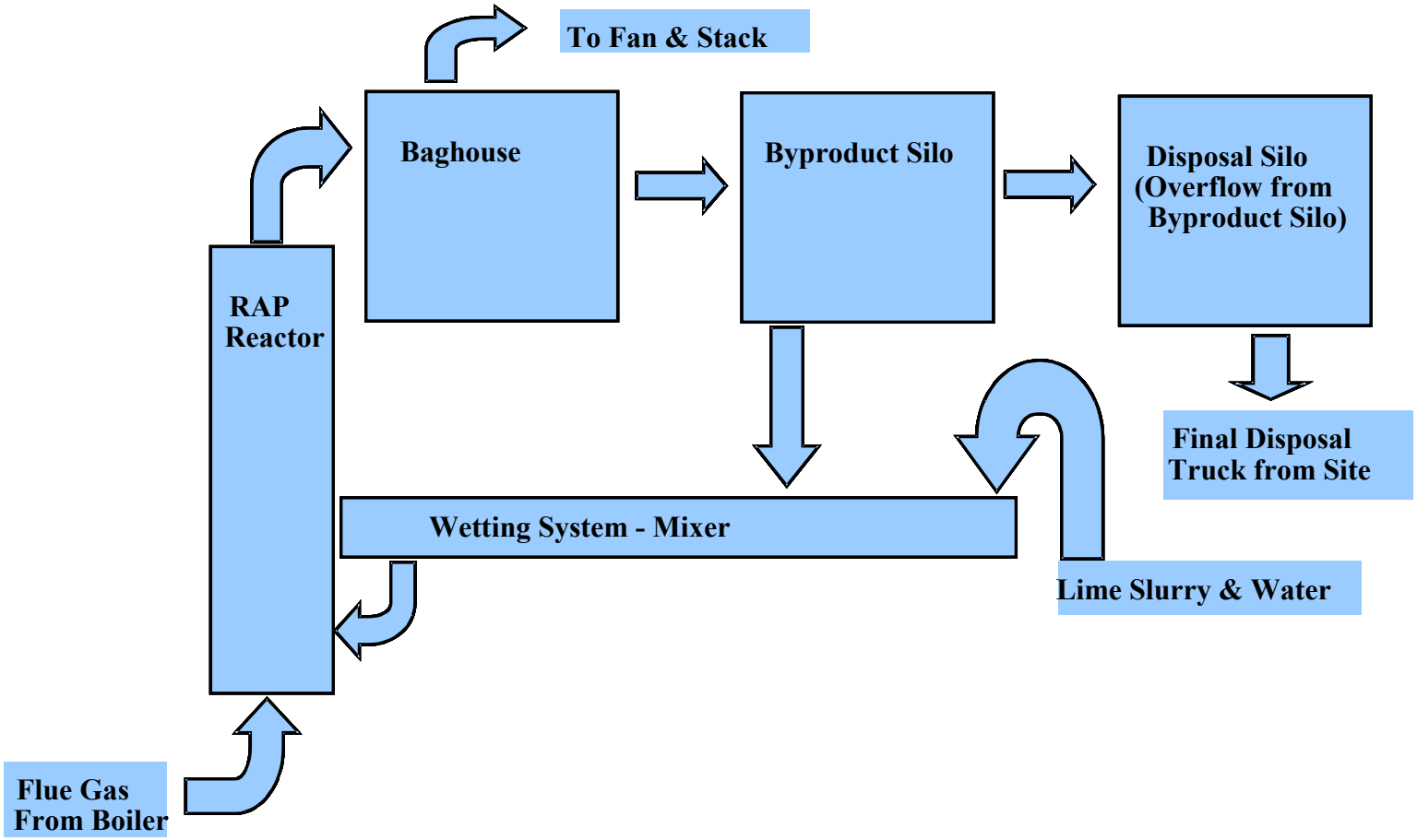
Rap System



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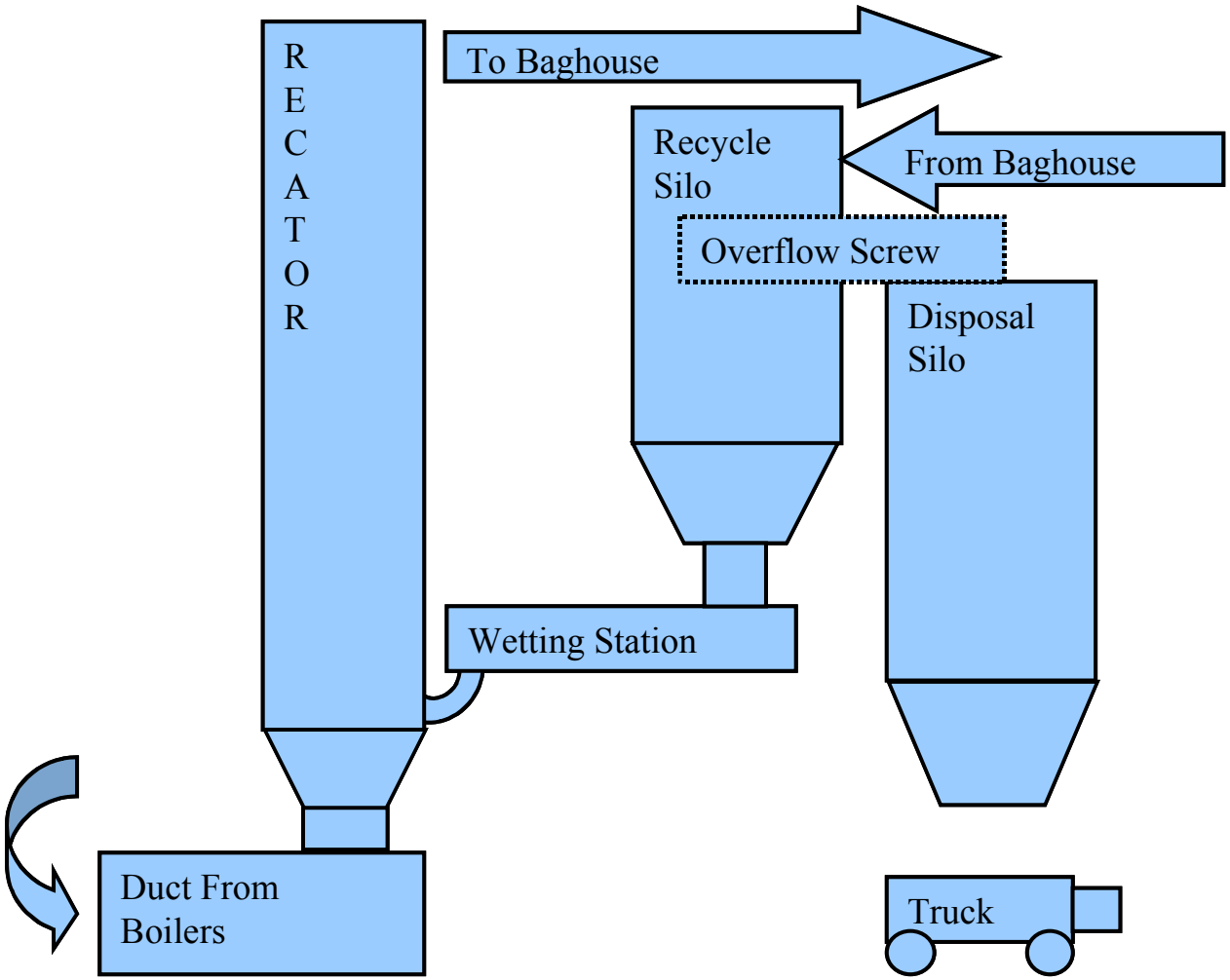
Material Handling



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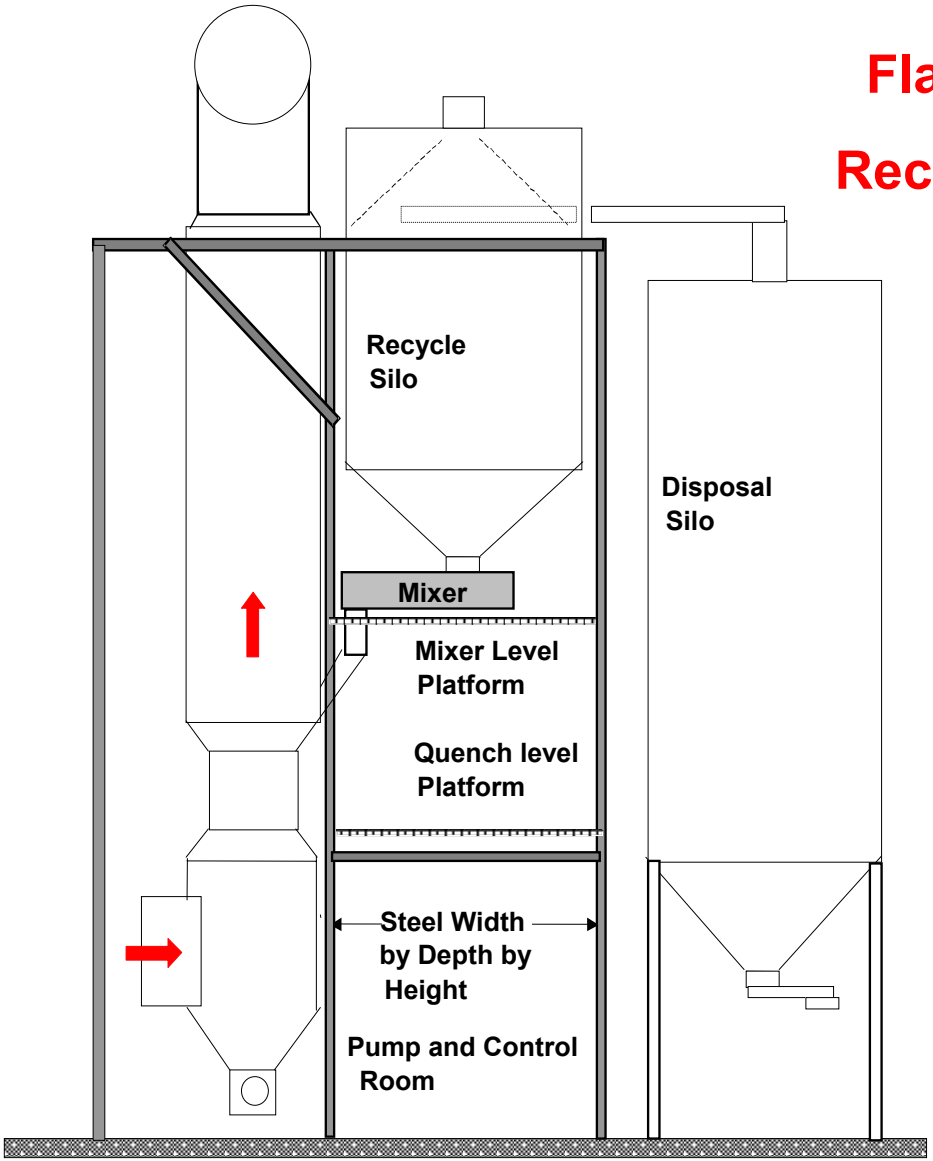
Flash Drying Process

Recycle From Baghouse



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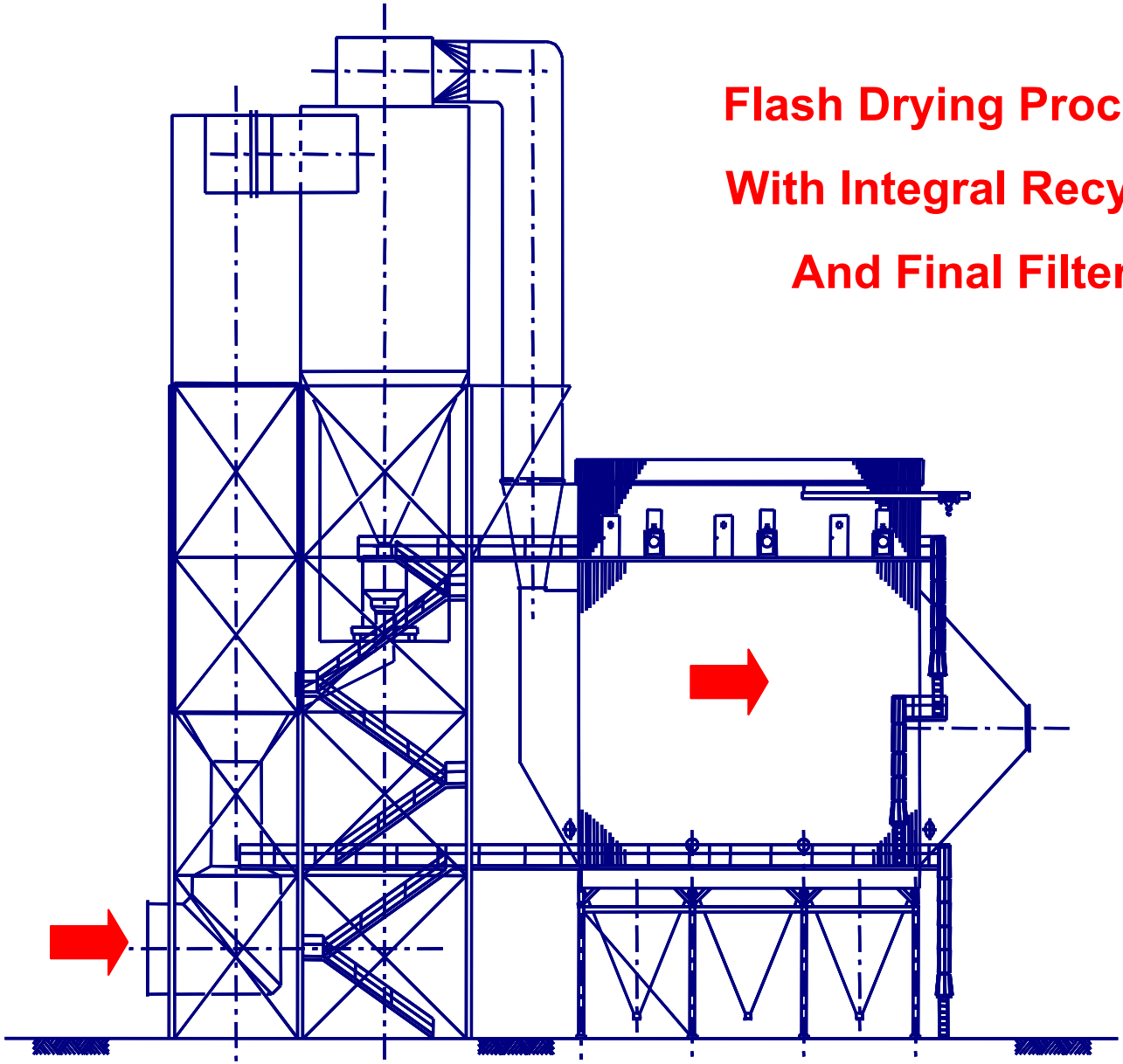
Flash Drying Process
With Integral Recycle
And Final Filter



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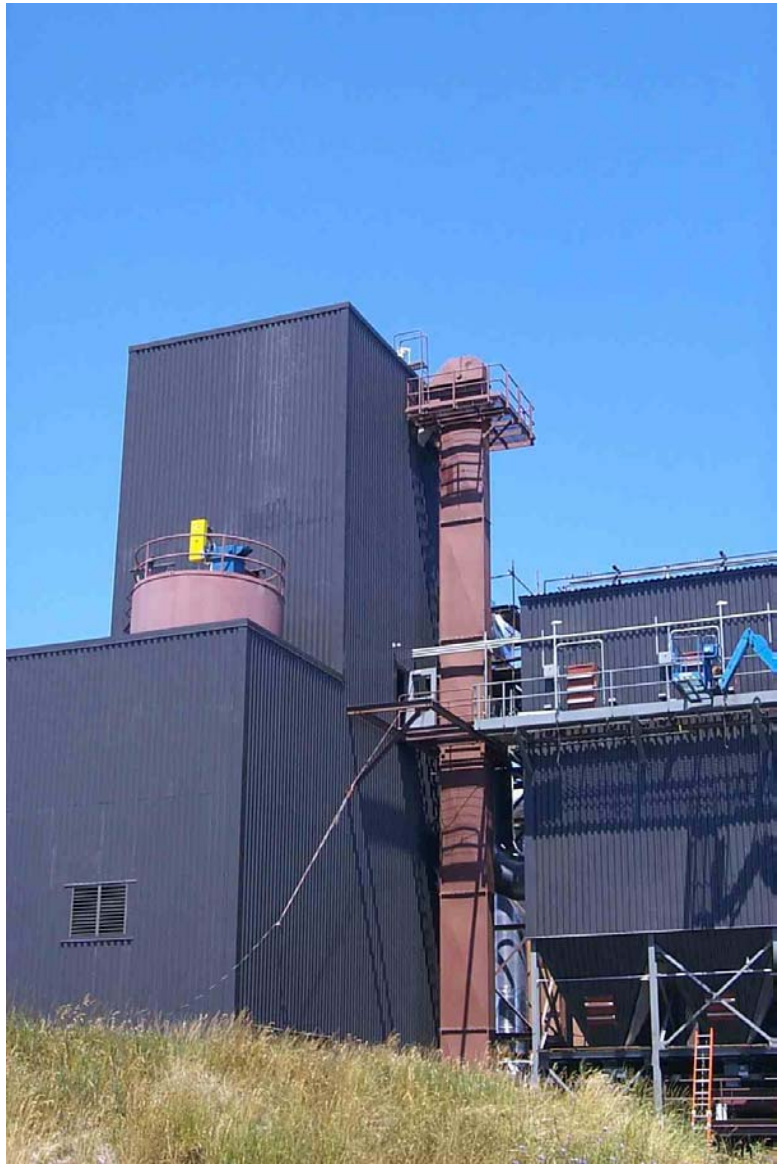

RAP Installation

MCO

Coal Fired Boilers

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Flash Dryer Improvements

- Maintain -or- Improve
  - Efficiency
  - Utilization
- Eliminate Internal Sprays
- Decrease Overall Height
- Eliminate Separate Recycle Loop
- Lower System Pressure Drop
- Improve Turndown Capability
- Simplify Controls
- Lower Capital Costs
- Reduce Cooling Water Requirements

Lime Silo and Slaker

Pre-Wired

Pre-Piped

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Slurry and Water Pumps

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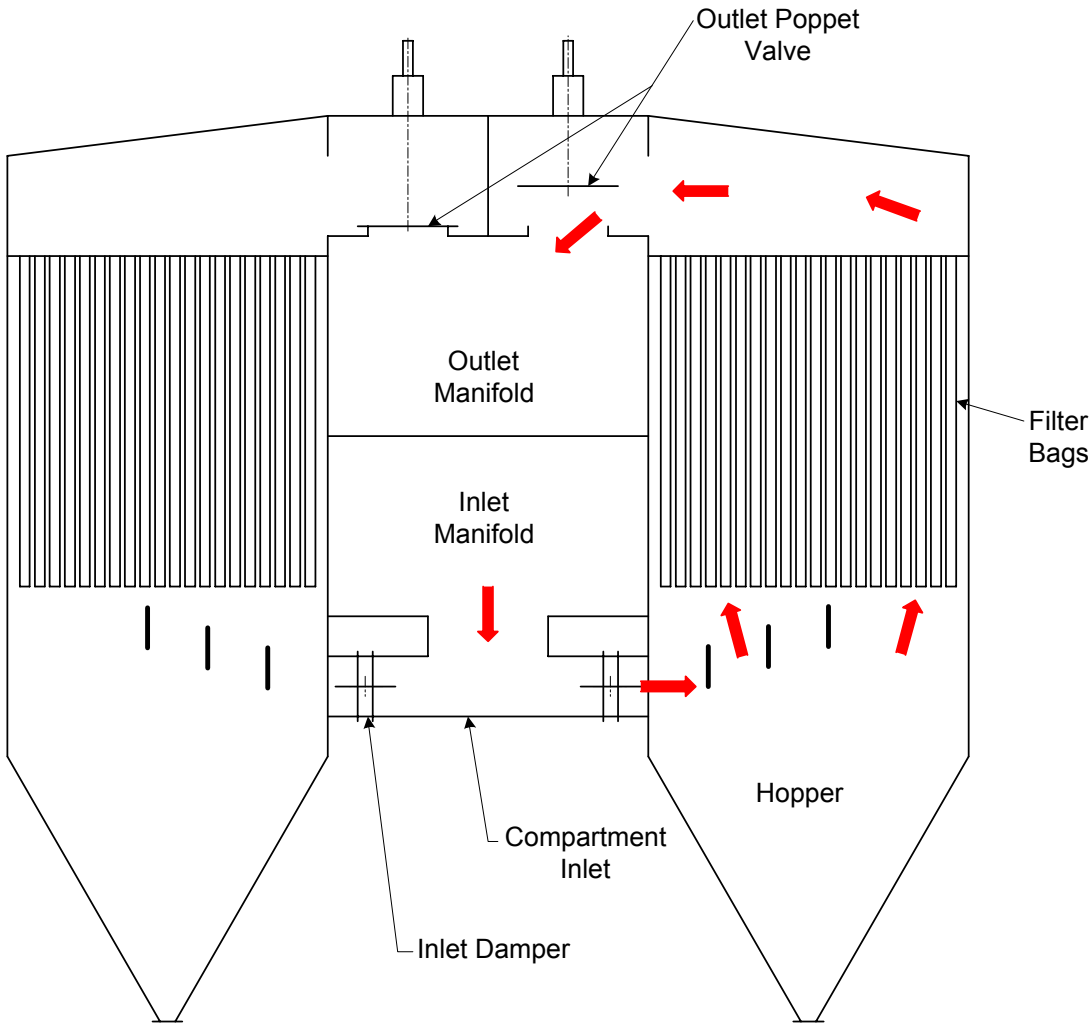
SO2 Control

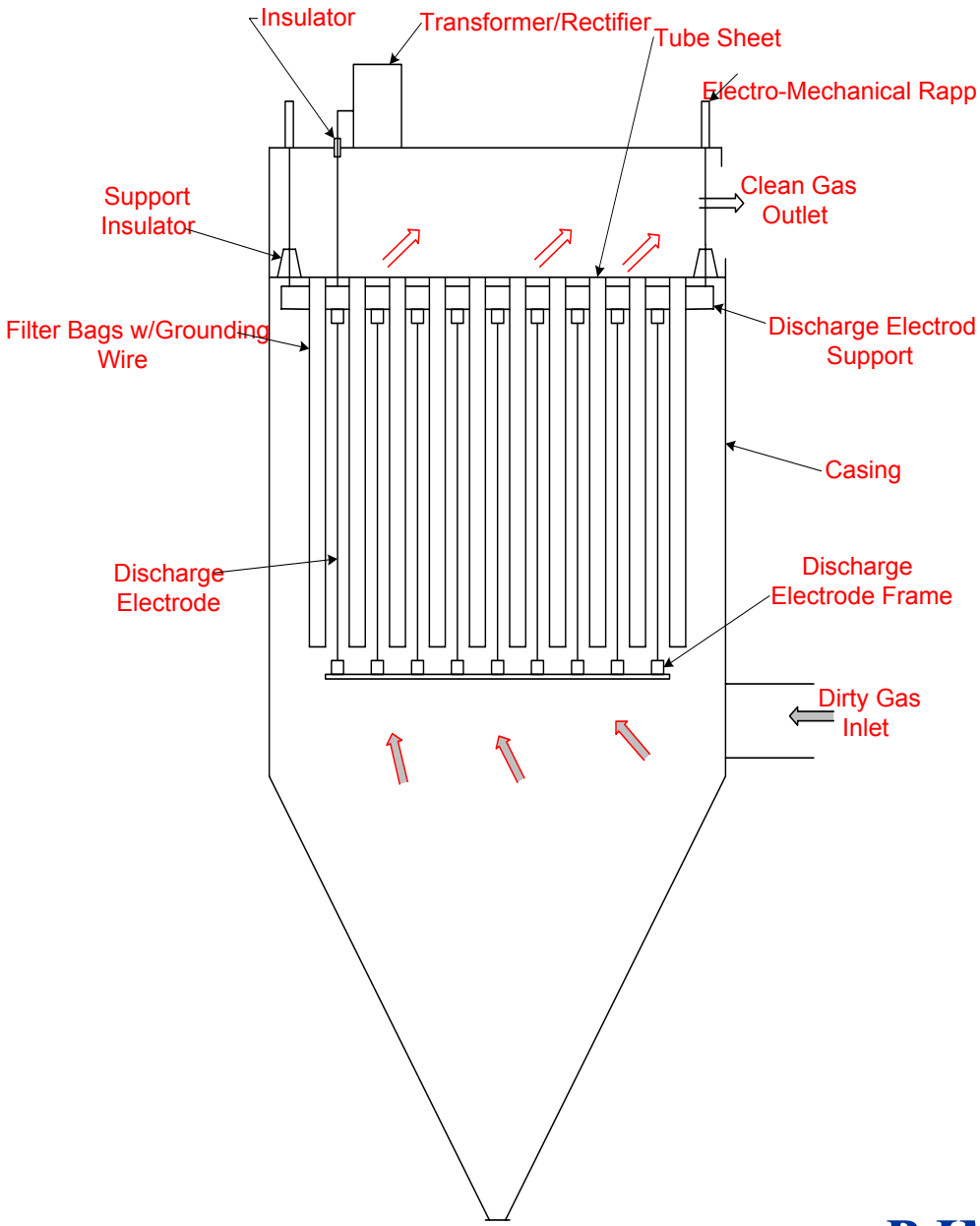
- 90 to 99% SO2 Removal
- High Outlet Temperature - 180 to 200 F
  - Less Potential corrosion
  - Reduces need for Reheat
  - Eliminates Special Chimney Liners
- High Utilization
- Requires Smaller Footprint
- Requires Less Power

Particulate Control

- For Multi-Pollutant Control a Pulse type Filter is recommended
- Filter should be designed for Recycle with High Inlet Grain Loadings
- Shorter Bags, Wider Spacing and Enhanced Cleaning Controls
- Use of Electro-Pulse will improve Fine Particulate Collection, Bag Life and Operating Pressure Drop

Pulse System Design & Cleaning System





Electro-Pulse Design

Charging& Cleaning System

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LECO®

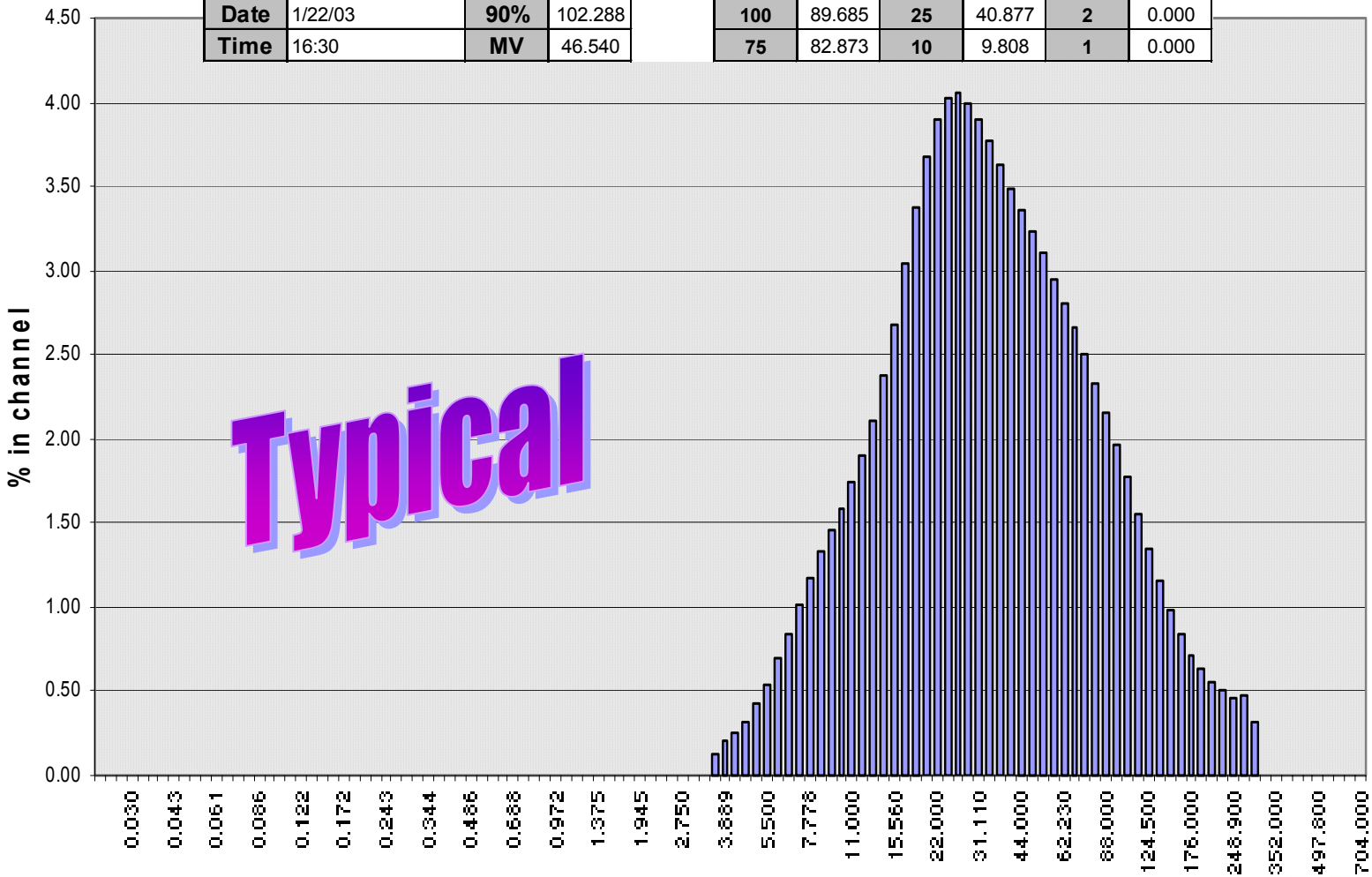
LECOTRAC

Particle Size Analyzer

Beaumont Environmental Systems
Medical College of Ohio
Sample 11/15/01
Size References are in Microns

ID #1	02-1015	10%	10.099
ID #2	Beaumont 11/15/01	50%	30.619
Date	1/22/03	90%	102.288
Time	16:30	MV	46.540

size	%pass	size	%pass	size	%pass
200	98.004	50	69.847	5	1.278
100	89.685	25	40.877	2	0.000
75	82.873	10	9.808	1	0.000



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Byproduct Material

- Material is Dry allowing Transport and Use
- Material Does Not Leach - Easy Disposal
- Material Can be Utilized for Fill
- Material can be integrated into byproduct building materials if no waste disposal is available

Capital & Costs USA Pricing

- Typical 80 to 150 MWe (and up as modules) Turnkey
  - $35 / KW For Flash Drying System $40 / KW For Pulse Type Fabric Filter
  - $400 / Ton SO2 for <1% Sulfur Coal
  - $200 / Ton SO2 for <3% Sulfur Coal
- Below 80 MWe Capital Costs Will Rise
- Above 150 MWe Capital Costs Fall

End of Presentation

Thank You