Particulate / SO2 Control Systems

Presented to

Council of Industrial Boiler Owners

December 8, 2009
Arlington, VA

Richard Saab

SESS - BEST TECHNICAL SOLUTION

SIEMENS

- Dedicated, Experienced Team Members
- Over 95 Years in Air Pollution Control
- Siemens Environmental is a leader in APC Systems
  - Fabric Filters
  - Electrostatic Precipitators
  - Wet Flue Gas Desulfurization
  - Dry Flue Gas Desulfurization
- Proven Project Execution Track Record
  - Fast Track & Tight Retrofit Experience
  - Equipment Meets Space Restrictions

Environmental Services Portfolio

SIEMENS

- Flue Gas Desulfurization
  - Wet / Dry (60 units)
  - Mercury Control (38 units)
- Electrostatic Precipitators
  - Wet / Dry (200 units)
- Fabric Filters(>200 units)
- NOx and Ancillary Products
  - SNCR (44 units)
- Multi-Pollutant Technology
  - Powerspan (1 unit)

Air Pollution Control Systems

SIEMENS

- Wet & Dry FGD Systems
- Fabric Filters
- Wet & Dry Electrostatic Precipitators
- Mercury Control Technology

SIEMENS

TYPICAL SULFUR DIOXIDE REMOVAL EFFICIENCIES

DUCT INJECTION	30-70%
DRY SORBENT REACTOR	50-75%
WITH HUMIDIFICATION	70-85%
SPRAY DRYER / ABSORBER	80-95%
WET SCRUBBER	95-98%

Since HCl is more reactive than SO2, all can achieve higher efficiencies for HCl.

PAC Injection for Mercury Control can be added to any of the above.

Dry Scrubbing Systems

SIEMENS

Dry Injection Systems - Economic Solution for Less Stringent Acid Gas Removal Requirements

- -Acid Gas Adsorption
- -Heavy Metals Control w/PAC

Lime Slurry Duct Injection Systems

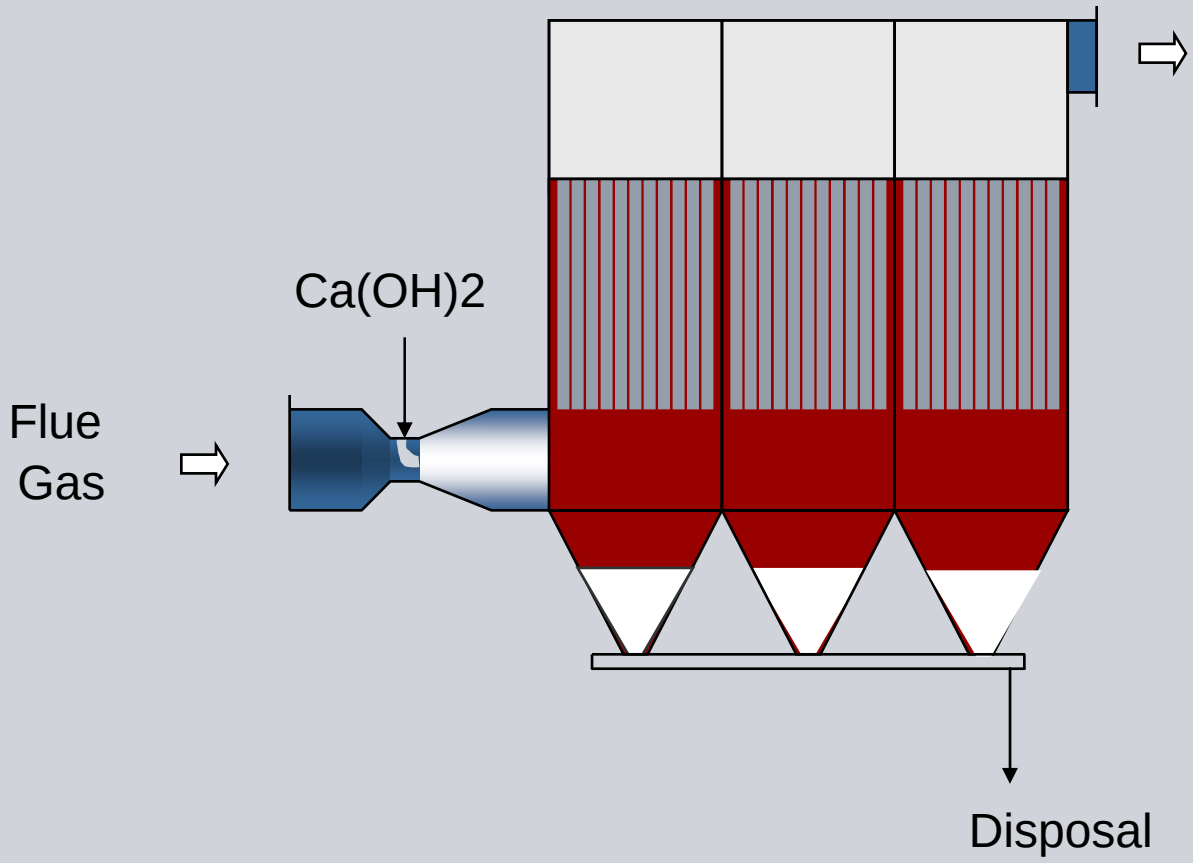
- -HCl/HF Control
- -Moderate SO2 Control
- -Heavy Metals Control w/PAC

Spray Dryer Absorbers

- -High SO_2/acid gas removal requirements
- -Heavy Metals Control w/PAC
- -Reaction Product Recycle to Improve Lime Utilization

Dry Injection System

SIEMENS



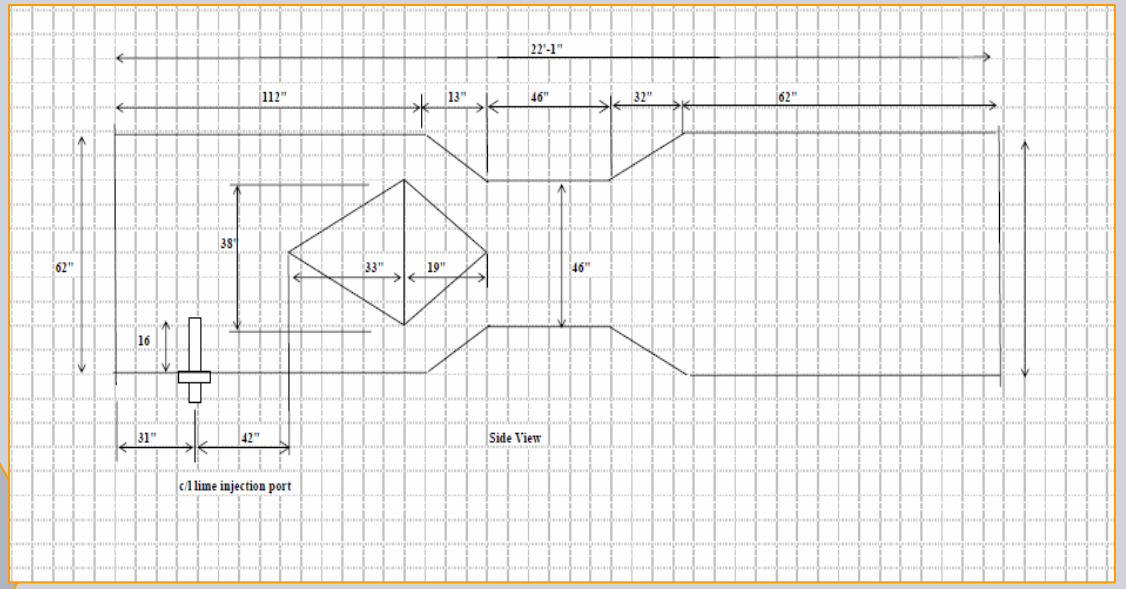
Duct Injection Systems

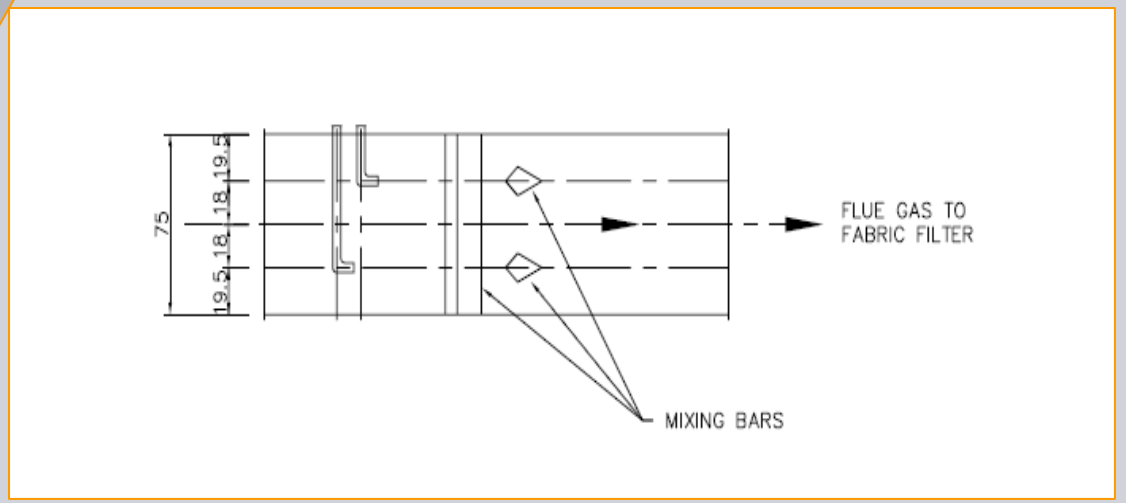
SIEMENS

Venturi Design

depends on:

- **Process Conditions**
- **Removal Requirements**
- **Reagent Type**





Duct Injection Systems

SIEMENS

Dry Injection System Limitations

SIEMENS

Particle Surface Area Limited

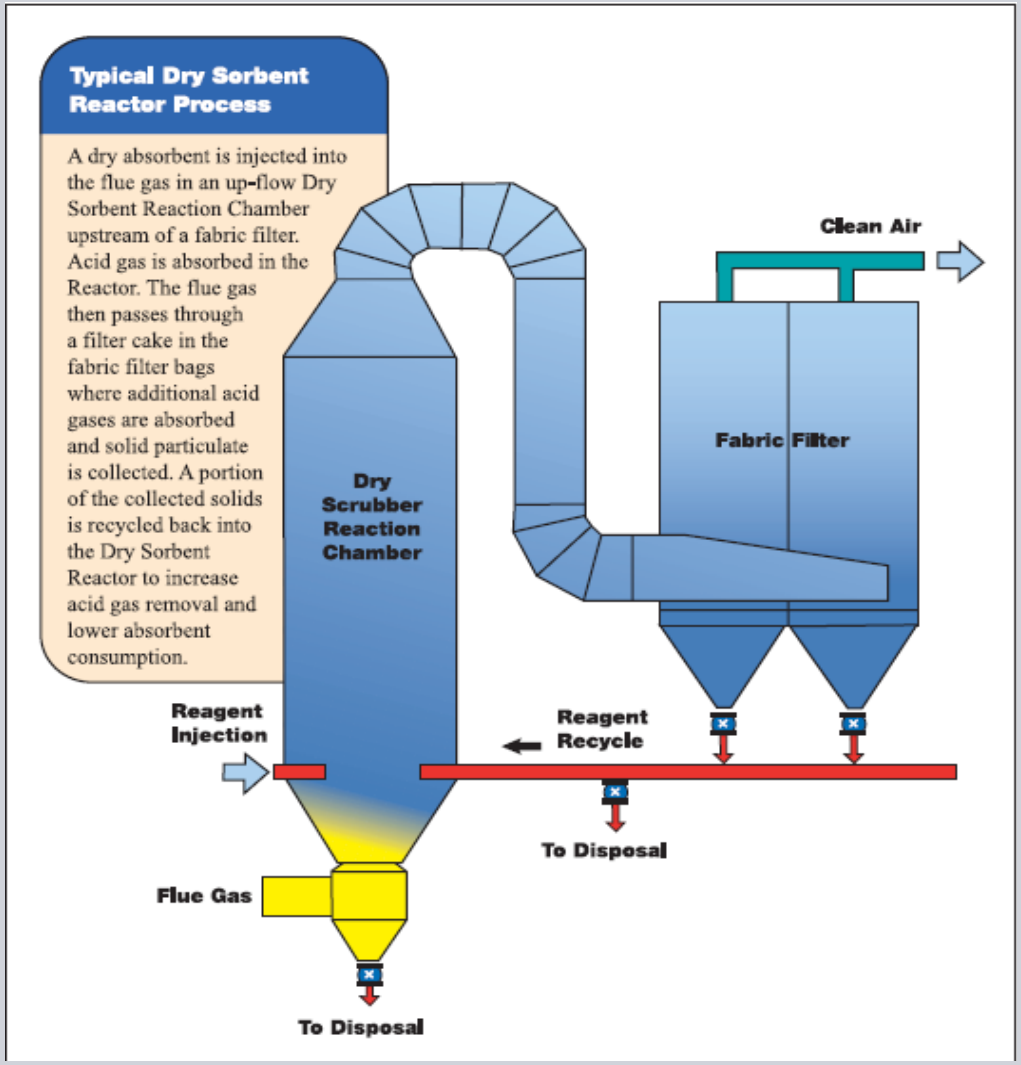
$CaSO_3$ / $CaCl_2$ Adsorbed Blinds Surface

$Ca(OH)_2$ below $CaSO_3$ / $CaCl_2$ Surface Layer Is Not Available for Reaction

Temperature Dependent

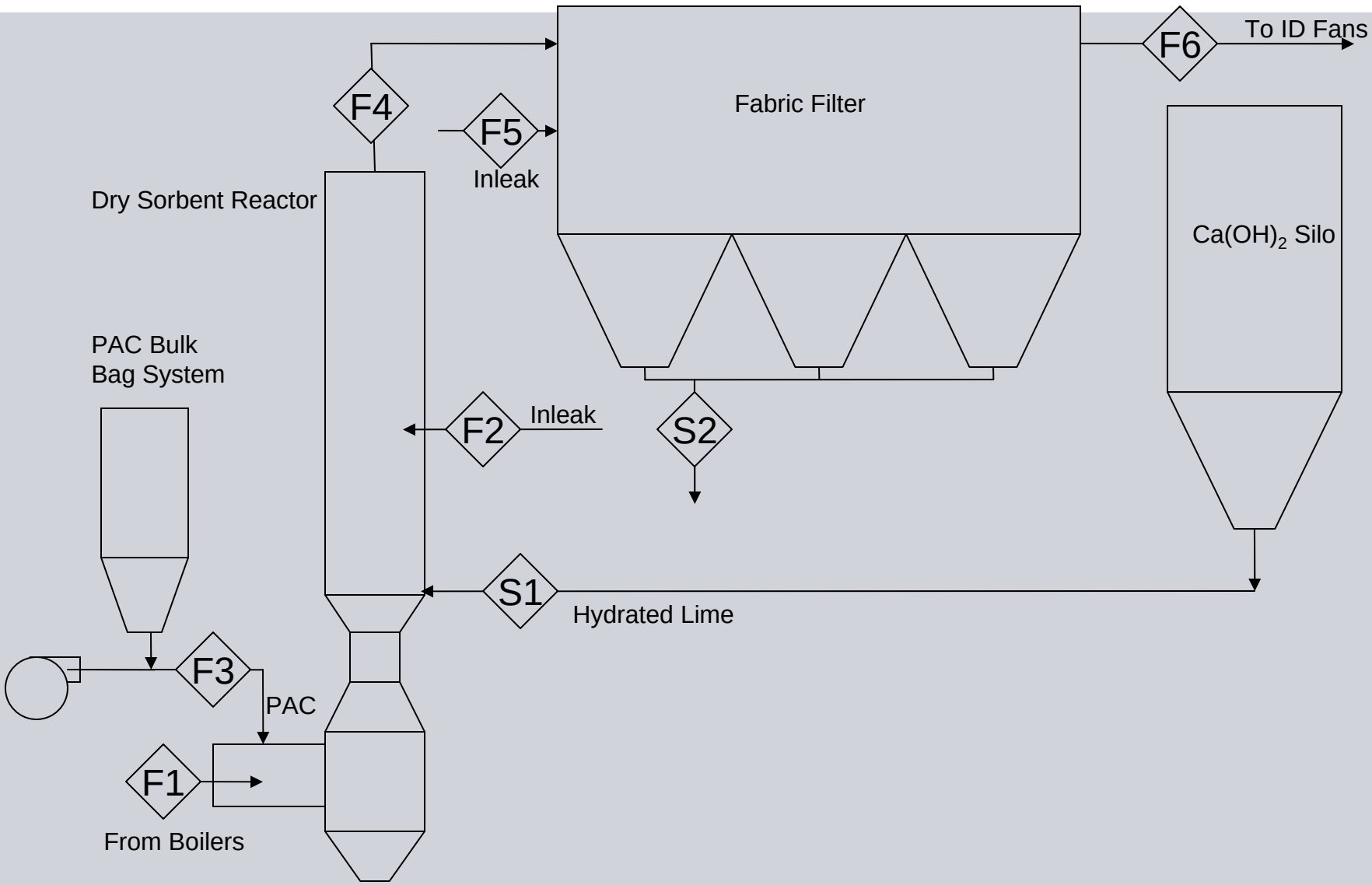
Dry Sorbent Reactor / Fabric Filter

SIEMENS



Dry Sorbent Reactor – Process Flow

SIEMENS



Spray Dryer Absorber (SDA)
Dry Scrubbing System

SIEMENS

Lime Slurry Atomized into Fluegas

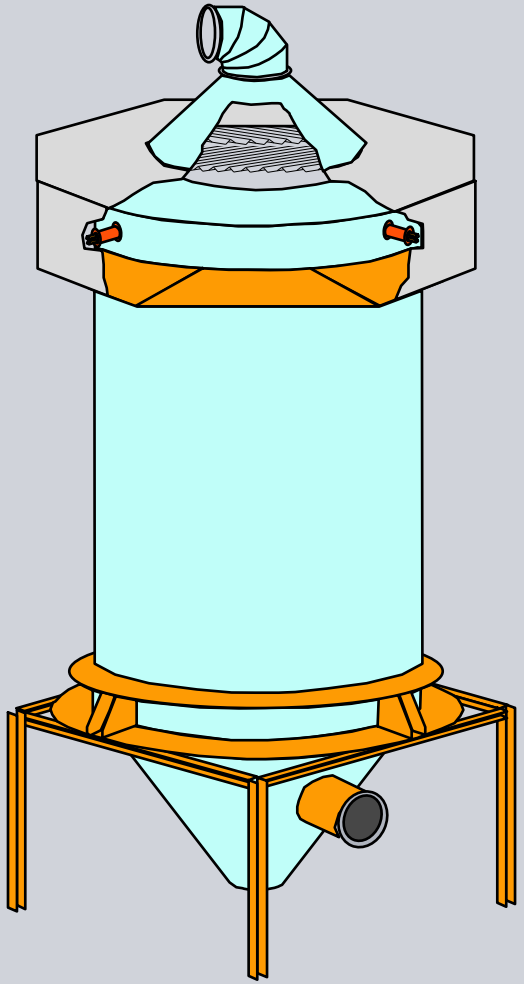
SO_2, Acid Gases Absorbed Into Droplet

Heat of fluegas Evaporates Slurry Water

Small Droplets / High Surface Area Promotes Evaporation

Cooled Flue Gas with Dried Reaction Products Ducted to Fabric Filter

Additional SO_2/Acid Gas is Adsorbed in Filter Cake on Bags



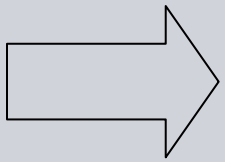
SIEMENS

KEY REACTION

$$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 \cdot \tfrac{1}{2}H_2O + \tfrac{1}{2}H_2O$$

Calcium Hydroxide

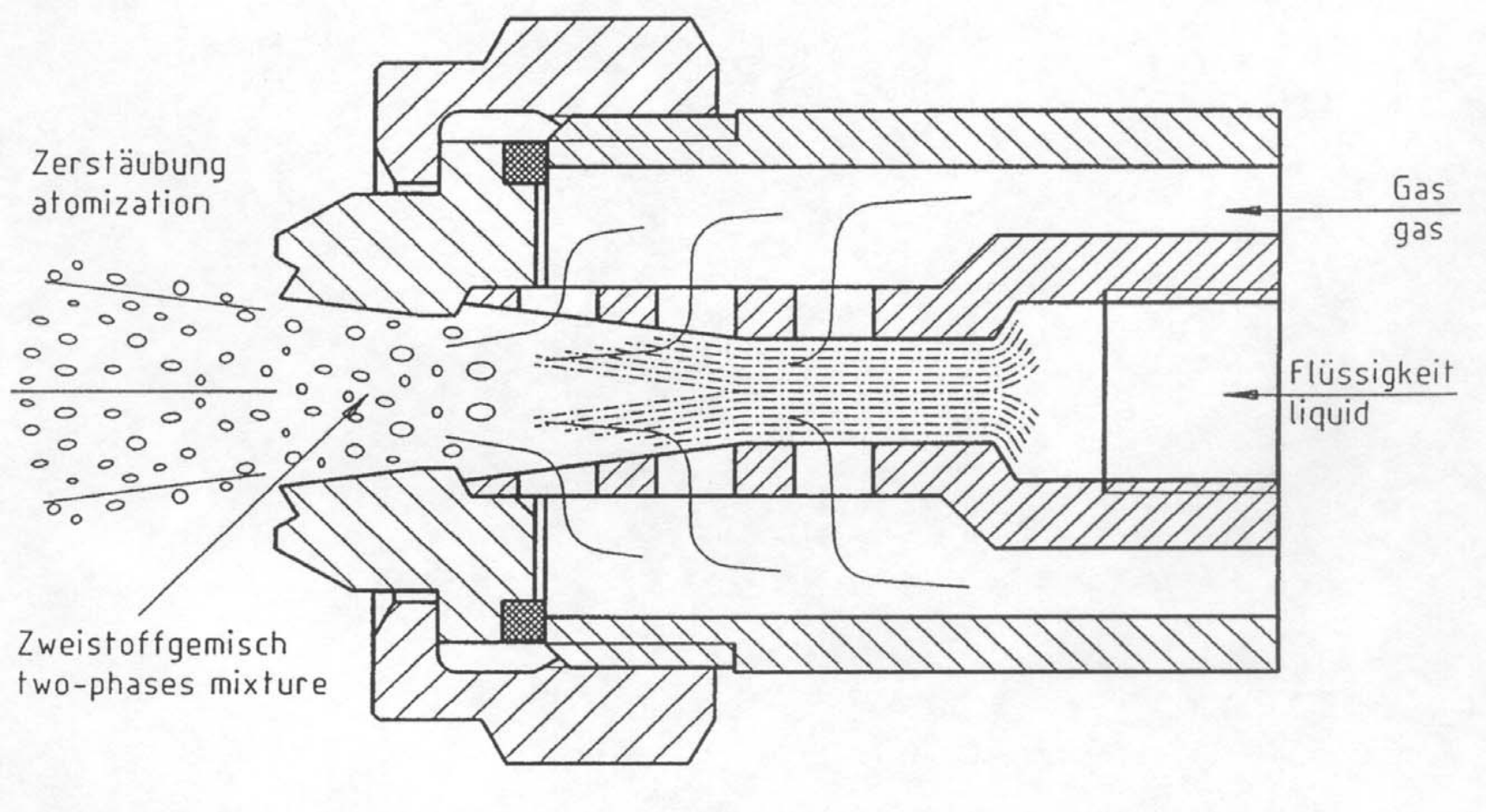
Sulfur Dioxide



Calcium Sulfite

Two Fluid Nozzle – Internal Mixing

SIEMENS



SDA/FF Dry Scrubbing Process

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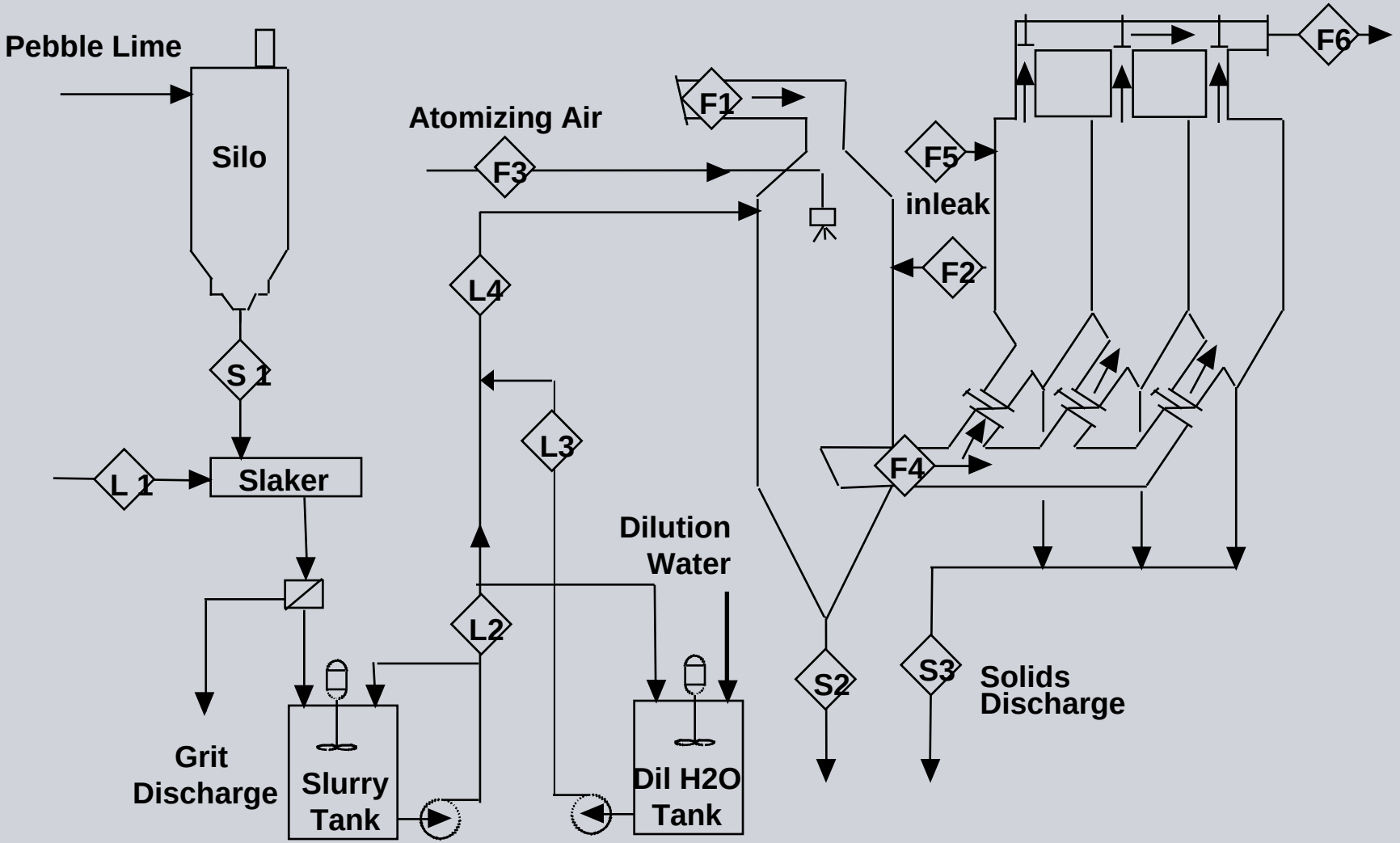


SDA On-Line Maintenance

SIEMENS

- **Isolate and Remove Nozzle Assembly - Flow is Distributed to Remaining Nozzles**
- **Install Spare Nozzle**
- **Clean/Inspect/Refurbish Nozzle**

Spray Dryer Absorber Experience

SIEMENS

Waste to Energy Plants

- **approx. 50 operating SDA's**
- **from 90 to 1000 TPD per train**
- **from 60,000 to 380,000 acfm**
- **2 x 1150 TPD starting up Summer 2010**

Spray Dryer Absorber Experience

SIEMENS

Circulating Fluidized Bed Boilers Florida

- **48’ DIA. SDA and JET VIP™ Pulse-Jet Fabric Filter**
- **2 x 300 MW**
- **836,700 ACFM**
- **Slurry Recycle System**

Spray Dryer Absorber Experience

SIEMENS

Multi Hearth Furnace
Southwest USA

- **12’-6” DIA. SDA**
- **JET III™ Pulse-Jet Fabric Filter**
- **40,000 ACFM**

Waste to Energy Plant
Midwest USA

SIEMENS

Fabric Filters

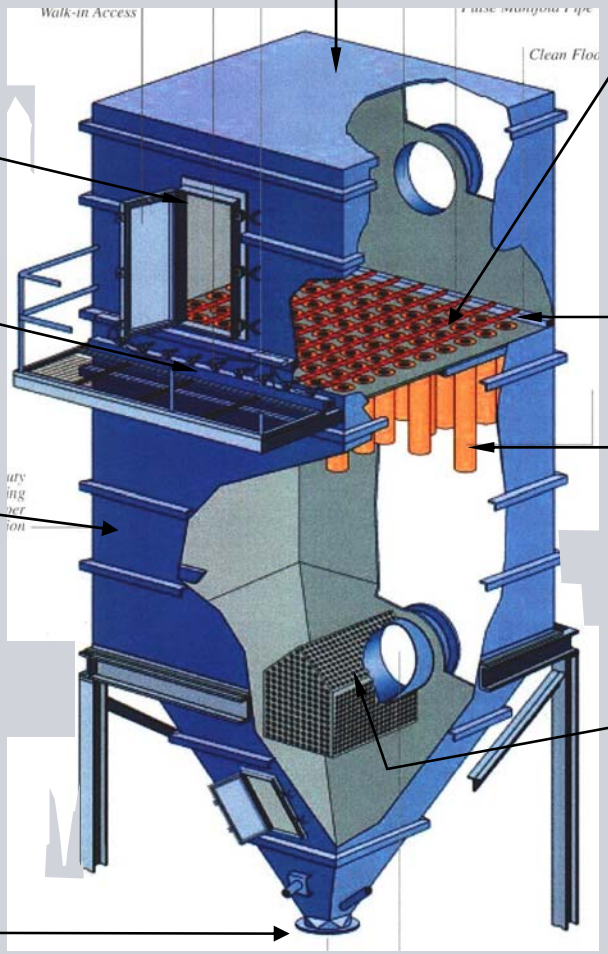
SIEMENS

Technology

- JET III™ Pulse System
- JET VIP™ Pulse System
- Reverse Air System
- Cartridge Collectors
- Shakers

JET III® Pulse Collector

SIEMENS



Fabric Filter Pulse Jet Technology

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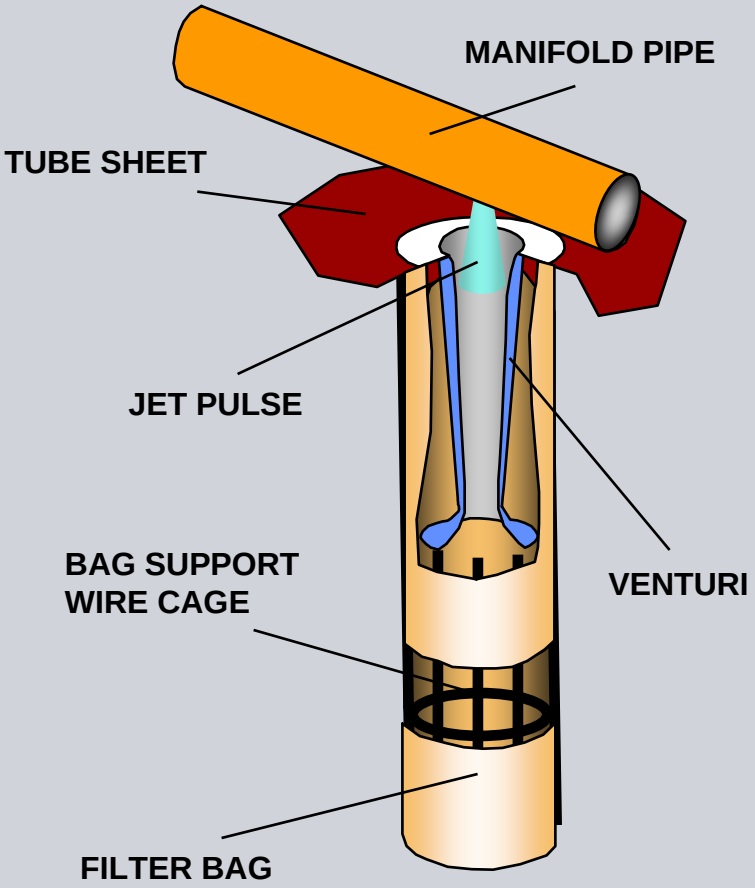
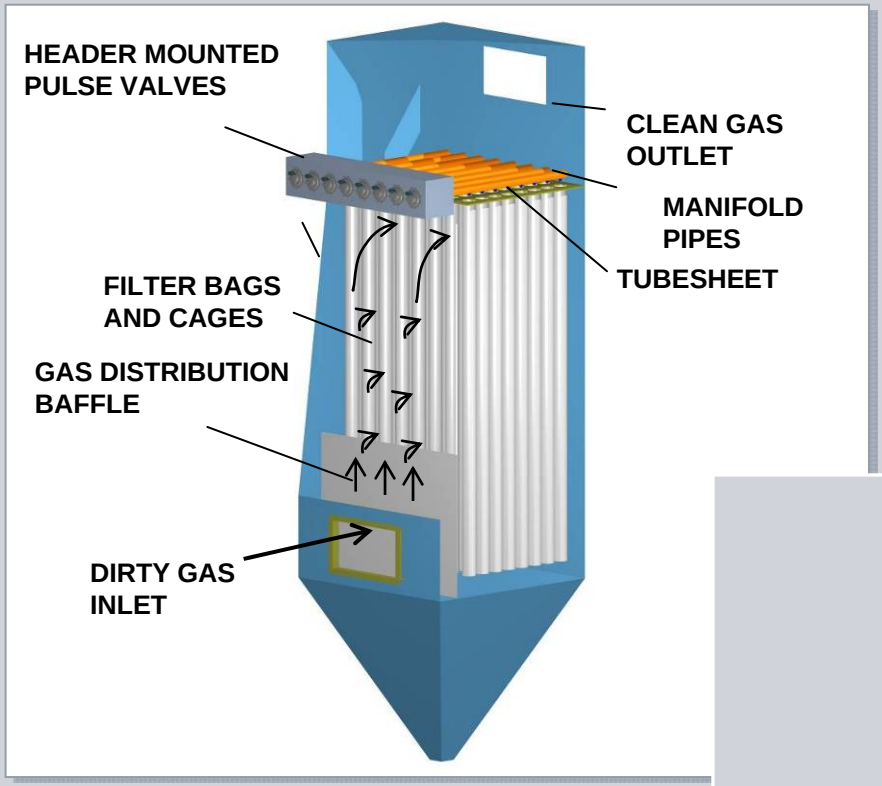


- High Performance
- Low Space Requirements
- Low Capital Cost
- Low Pressure Drop
- On-line or Off-line Cleaning

Fabric Filter Technology
JET VIP™ Pulse Systems

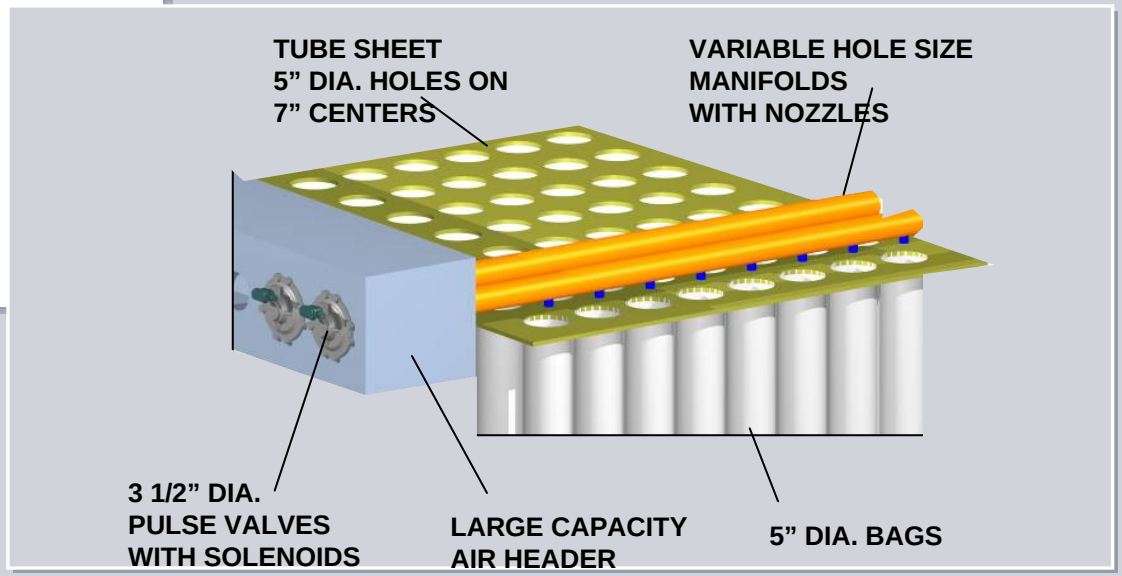
SIEMENS



Advantages

- On-line Cleaning
- Smaller Footprint
- Gentler Pulsing =

Longer Bag Life

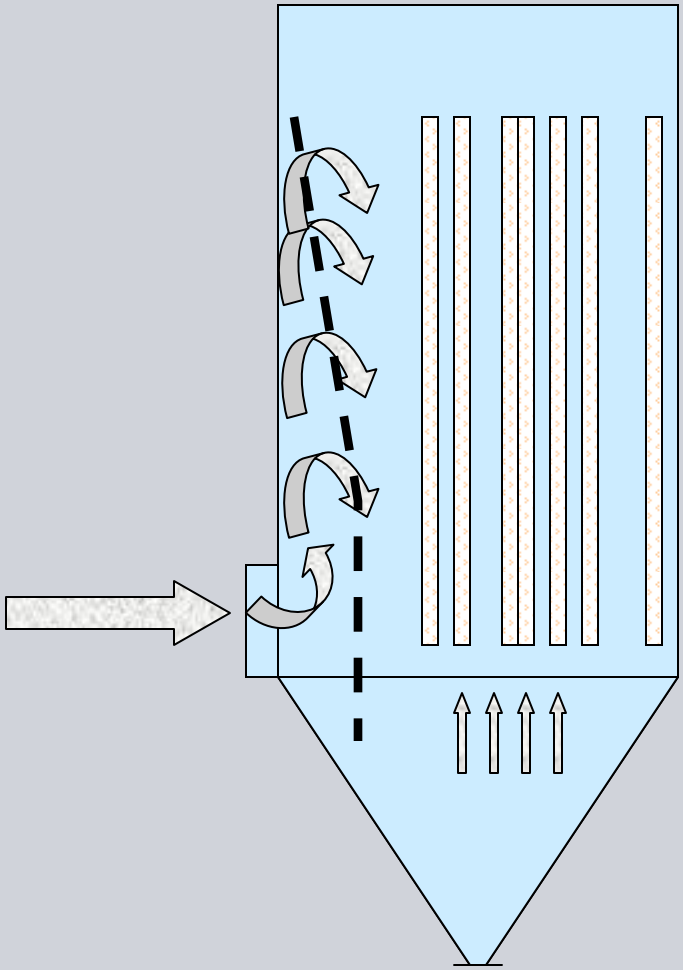


JET VIP™ Pulse Systems

SIEMENS

V IP Pulse Jet
Gas Flow Distribution

- Split Gas Entry
- Low “Can” Velocity
- Minimizes Re-entrainment
- On-Line Cleaning
- Low Cleaning Frequency



JET VIP™ Fabric Filter

SIEMENS

Coal Fired Boilers
Michigan

- **JET VIP Pulse Jets**
- **Units 5, 6 – 462,000 ACFM each**
- **Units 7, 8, 9 – 1,200,000 ACFM**
- **90 MW / Unit**

Dry Sorbent Reactor / Fabric Filter

SIEMENS

Coal Fired Boiler
Illinois

- **Dry Sorbent Reactor with JET VIP Pulse Jet**
- **530,000 ACFM**
- **SO2, HCl, Particulate and Mercury Control**

JET VIP™ Fabric Filter

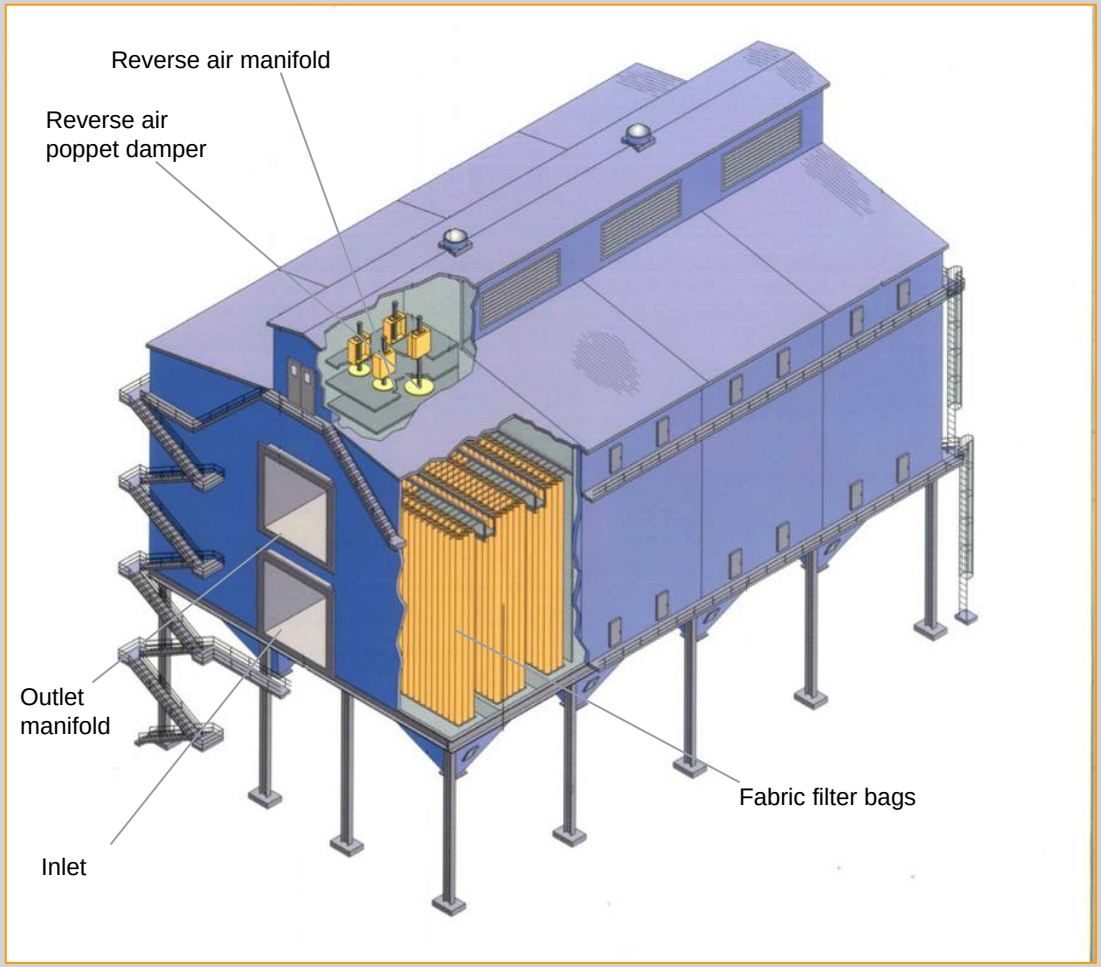
SIEMENS

Biomass Wood Waste Fired Boiler Canada

- **JET VIP Pulse Jets**
- **240,000 ACFM**
- **0.010 lb/mmBTU particulate guarantee**

Reverse Air Fabric Filter

SIEMENS



Reverse Air Fabric Filter

SIEMENS

Coal Fired Boilers
Nebraska

- **Largest Reverse Air Fabric Filter System in U.S.**
- **715 MW / 745 MW**

Electrostatic Precipitators (Dry)

SIEMENS

Technology

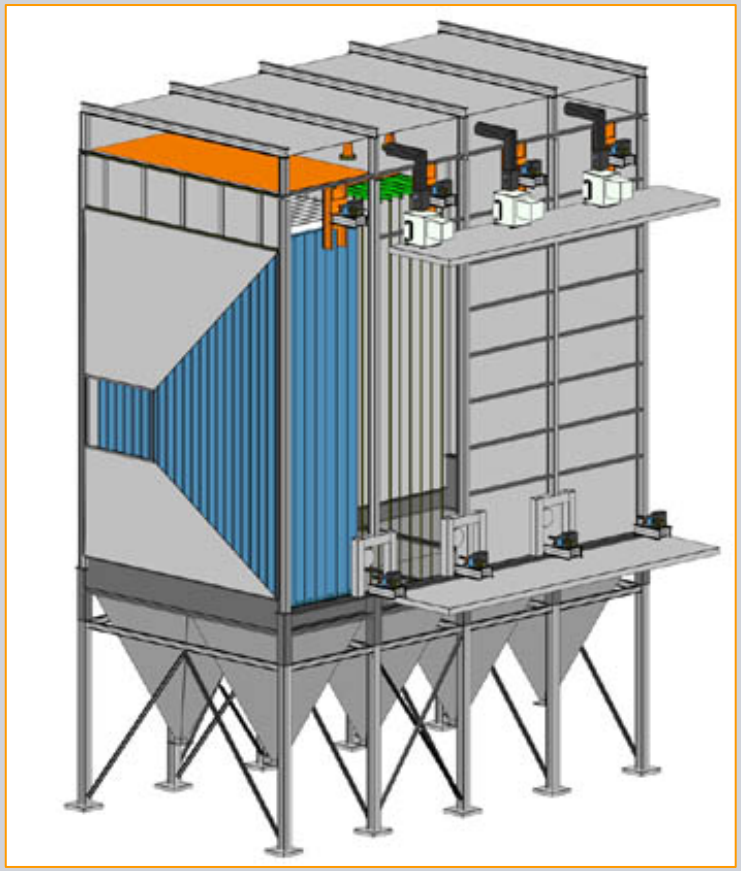
- **HaRDE® Electrostatic Precipitator**
  - Rigid Discharge Electrodes with tumbling hammer rapping

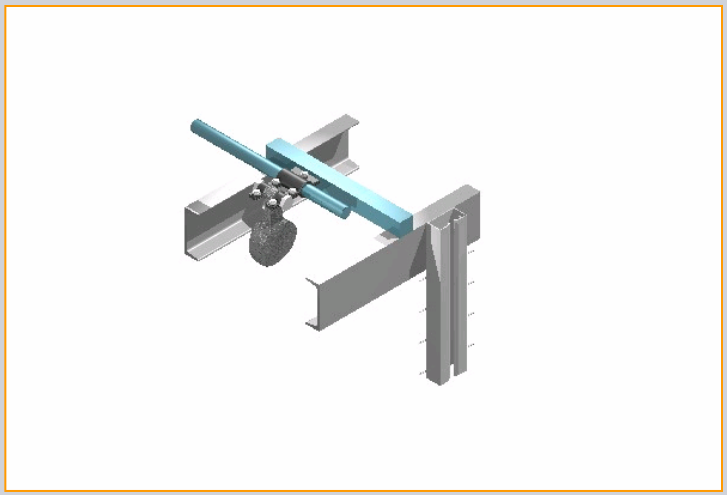
- **VIGR™ Electrostatic Precipitator**
  - Rigid Discharge Electrodes with magnetic impulse rapping

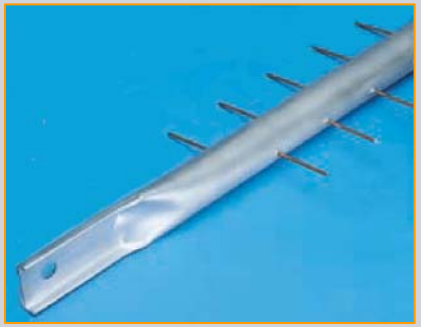
HaRDE® Electrostatic Precipitator

SIEMENS

Rigid Discharge Electrodes & Tumbling Hammer Rapping







HaRDE® Electrostatic Precipitator

SIEMENS

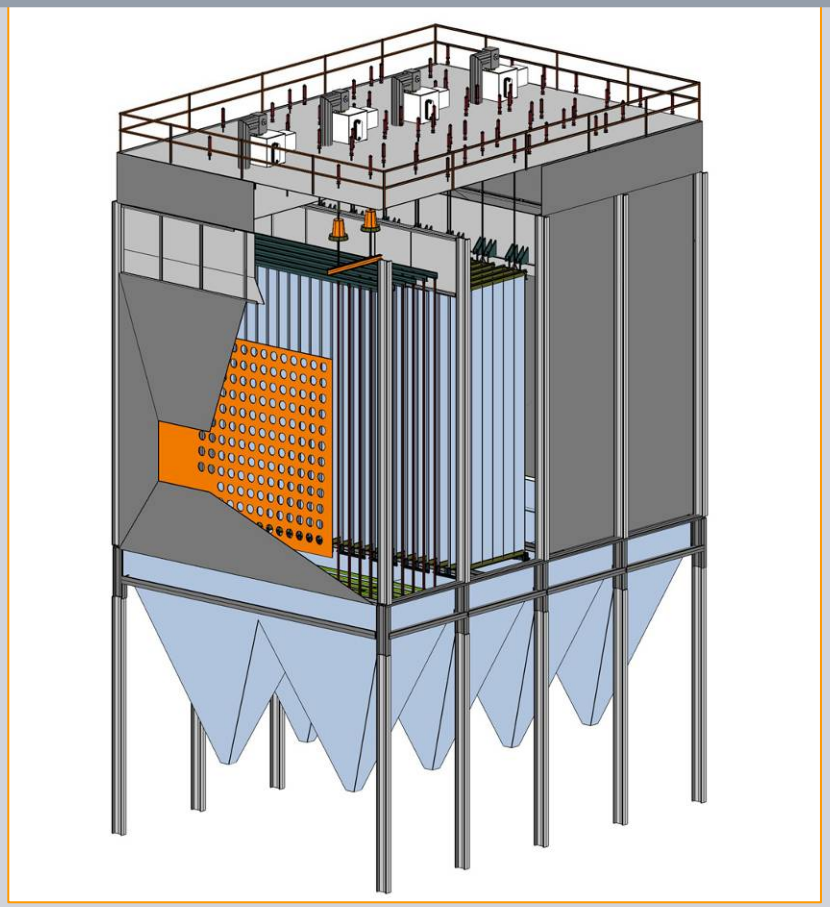
Santee Cooper
Cross Generating Station
Units 3 & 4
Cross, SC

- **HaRDE®**
- **16” wide plate spacing**
- **Coal-fired boilers**
- **600 MW / unit**
- **2,100,000 ACFM**

VIGR™ Electrostatic Precipitator

SIEMENS

Rigid Discharge Electrodes & Magnetic Impulse Rapping



SIEMENS

VIGR™ Electrostatic Precipitator

PPL Corporation
Montour Station Units 1 & 2
Washingtonville, PA

- **VIGR™ Electrostatic Precips**
- **16-inch wide plate spacing**
- **NOx SCR**
- **745 MW / 755 MW**
- **Coal-Fired Boiler**
- **2,800,000 ACFM**

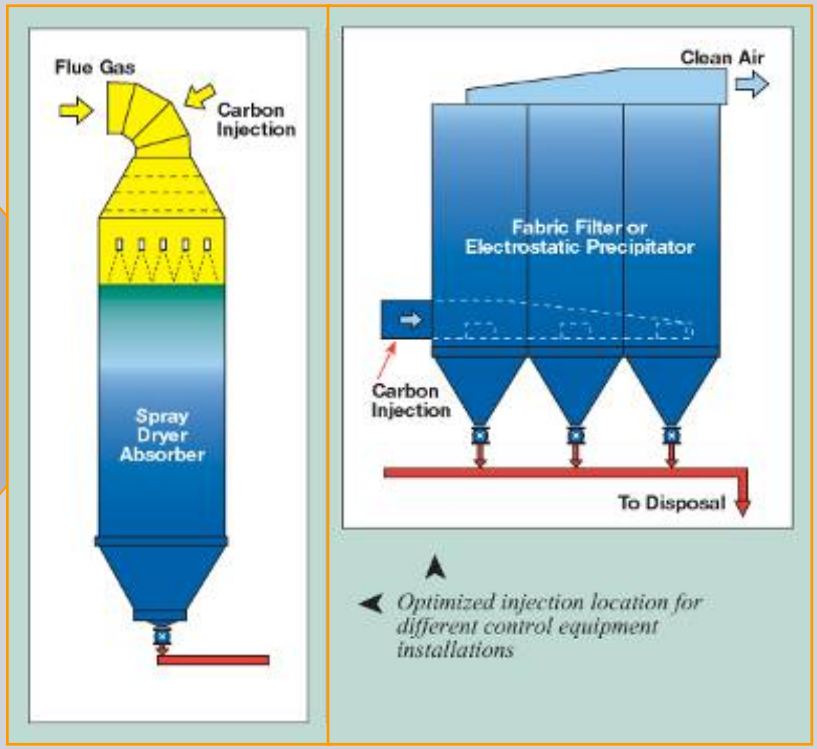
Mercury Control
Powdered Activated Carbon (PAC) Injection

SIEMENS

Injected upstream of particulate control device

Mercury binds with PAC in flue gas

80 to 95% removal with PAC



JET VIP™ Fabric Filter with Mercury Control

SIEMENS

Coal Fired Boiler
Nebraska

- **JET VIP Pulse Jets**
- **146,000 ACFM**
- **PAC injected into FF Inlet ductwork**

Most advanced “Multi Pollution” removal system
NEW Coal Plant Environmental Scope
E.ON - LG&E Trimble Unit 2 - $138M 48 Months

SIEMENS

- New 800 MW Coal Fired Unit
- Integrated Air Quality Control System
  - Dry ESP
  - Activated Carbon/ Hydrated Lime
  - Fabric Filter
  - Wet FGD
  - Wet ESP
- State of the Art Emission Limits
  - SO_2, Acid Mist, Halides, Particulates including condensables, Mercury and Heavy Metals
- Long Term Air Quality Control Systems Service Agreement
  - Expandable to all LG&E System

SESS - BEST TECHNICAL SOLUTION

SIEMENS

Thank you.

Questions?