Dry FGD and Fabric Filter Training Session

2008 APC / PCUG Meeting
July 13, 2008
Savannah, GA

Worldwide Pollution Control Association

A non-profit organization whose mission is to improve pollution control through better technical communication.

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Dry FGD and Fabric Filter Training Session

Dry FGD Fundamentals	Kevin Redinger, B&W
Break	
Dry FGD Process Equipment	John Buschmann, Alstom Power
Break	
Fabric Filter Fundamentals for FGD	Coni Williams, GE Energy
Open Discussion of Common Operating Issues	All

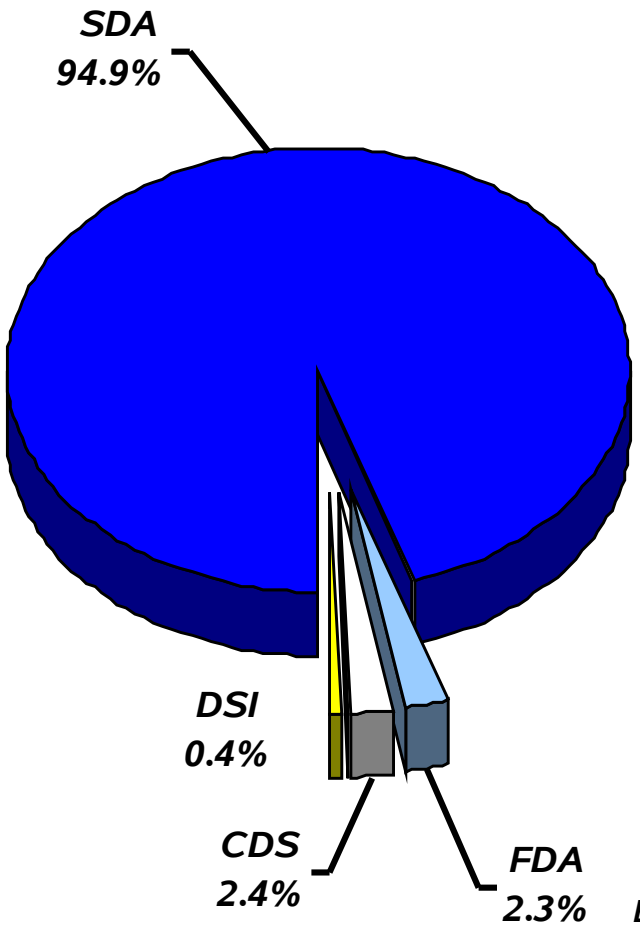
"Dry FGD" Can Have Several Meanings

- Furnace Sorbent Injection (FSI)
- Dry Sorbent Injection (DSI)
- Spray Dry Absorption (SDA)
- Flash Dry Absorption (FDA)
- Circulating Dry Scrubbers (CDS)

Spray Dry FGD Technology Fundamentals

- Coal-Fired Dry FGD Installations
- SDA Process Fundamentals
- SDA Process Flowsheets
- Key Operating Considerations
- Typical Performance Requirements

US / Canadian Coal-Fired Dry FGD Installations
by Dry FGD Technology



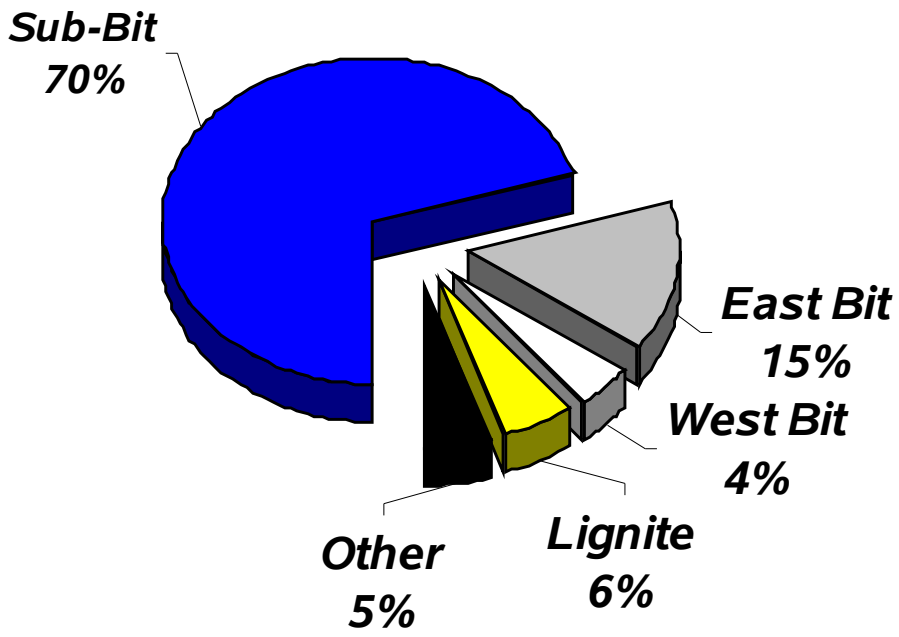
B&W Estimate based on market data July, 2008

US / Canadian Coal-Fired SDA Installations

by Coal Type

US / Canadian Coal-Fired Spray Dry FGD Systems

% of Total 36,120 MW Installed / Committed



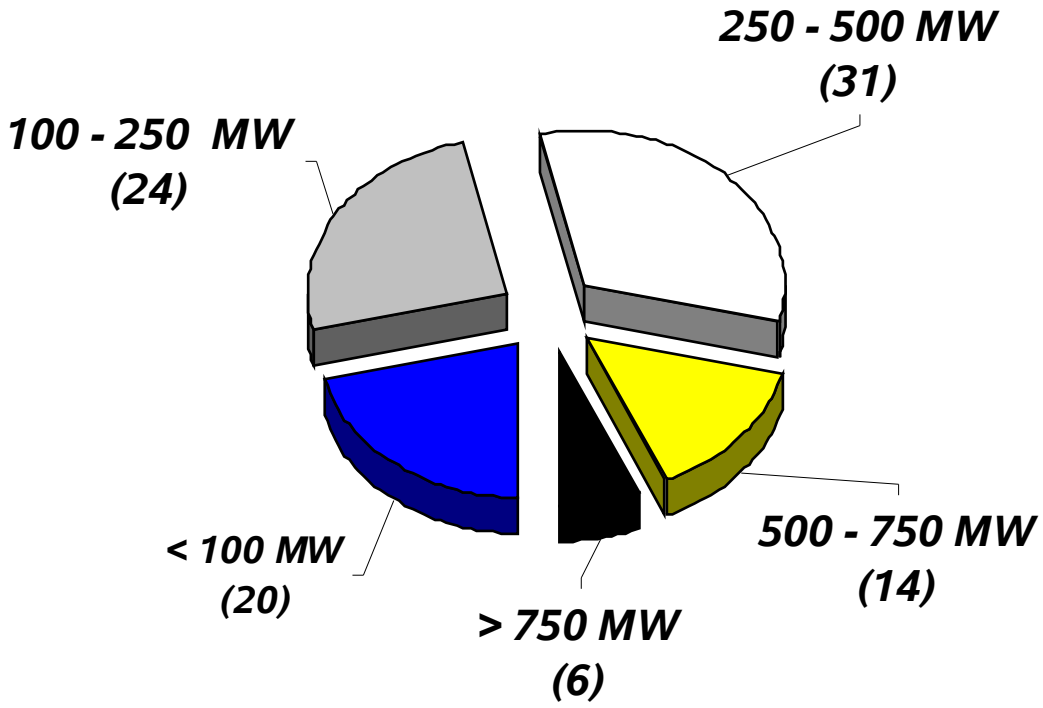
B&W Estimate based on market data July, 2008

US / Canadian Coal-Fired SDA Installations

by Unit Generating Capacity

US / Canadian Coal-Fired Spray Dry FGD Systems

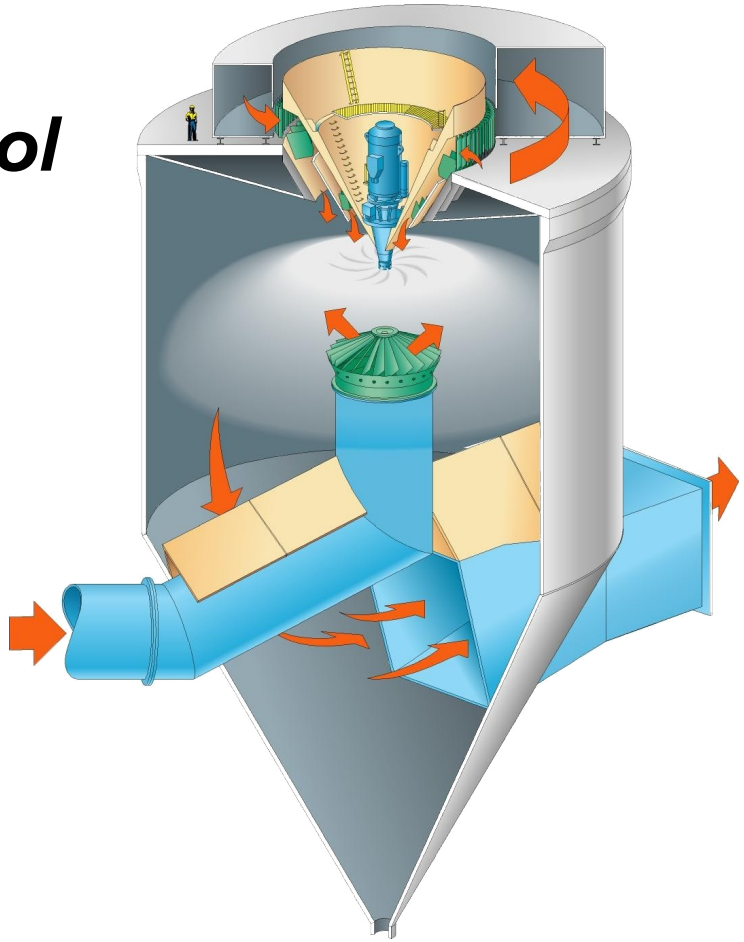
Total Installations / Committed Projects by Unit Size



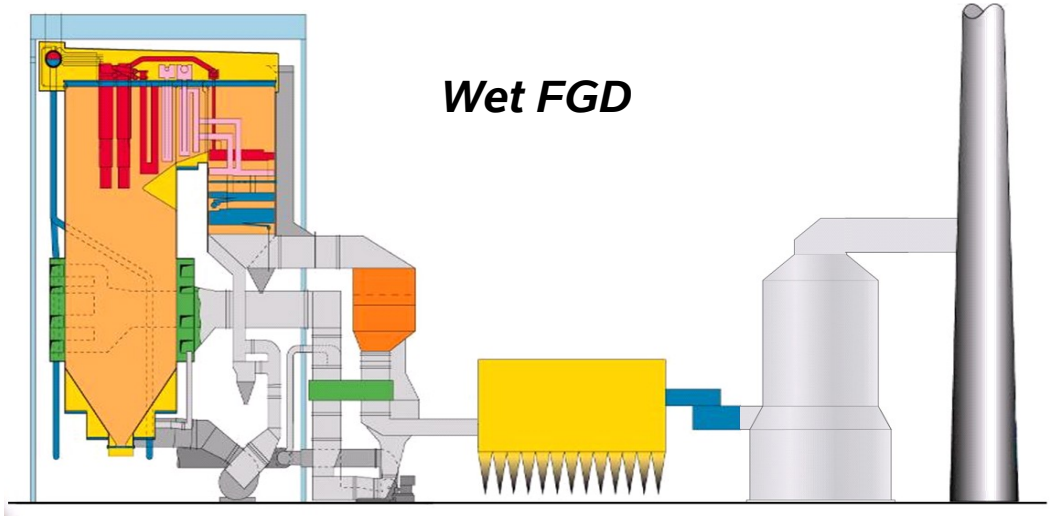
B&W Estimate based on market data July, 2008

SDA Process Fundamentals

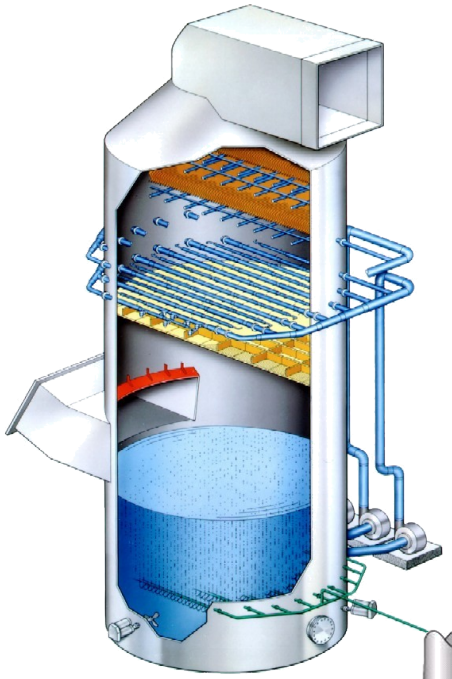
- *AQCS Configuration*
- *Two stage emissions control*
- *Slurry Atomization*
- *Absorption and drying*
- *Terminology*

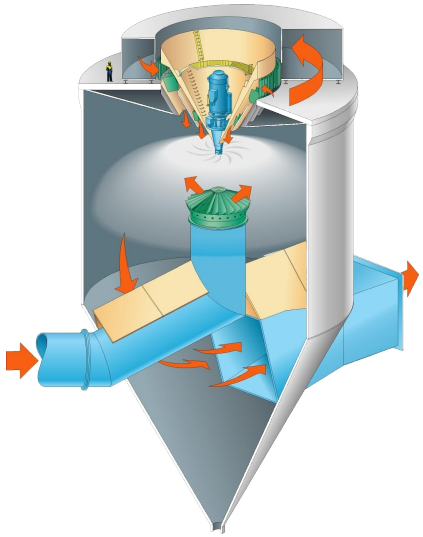


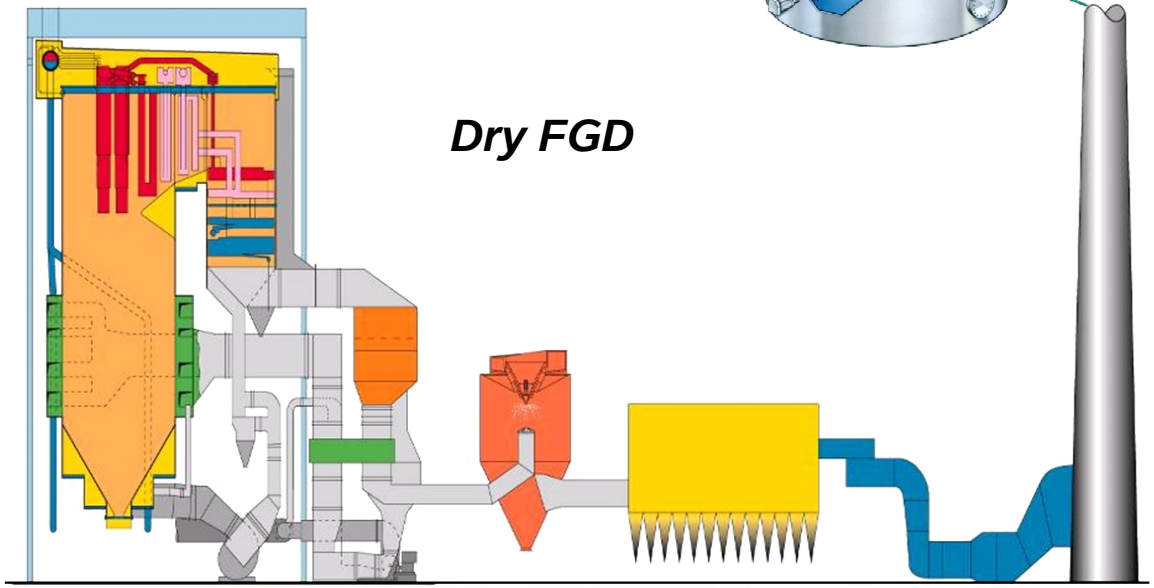
Typical FGD Configurations



Wet FGD

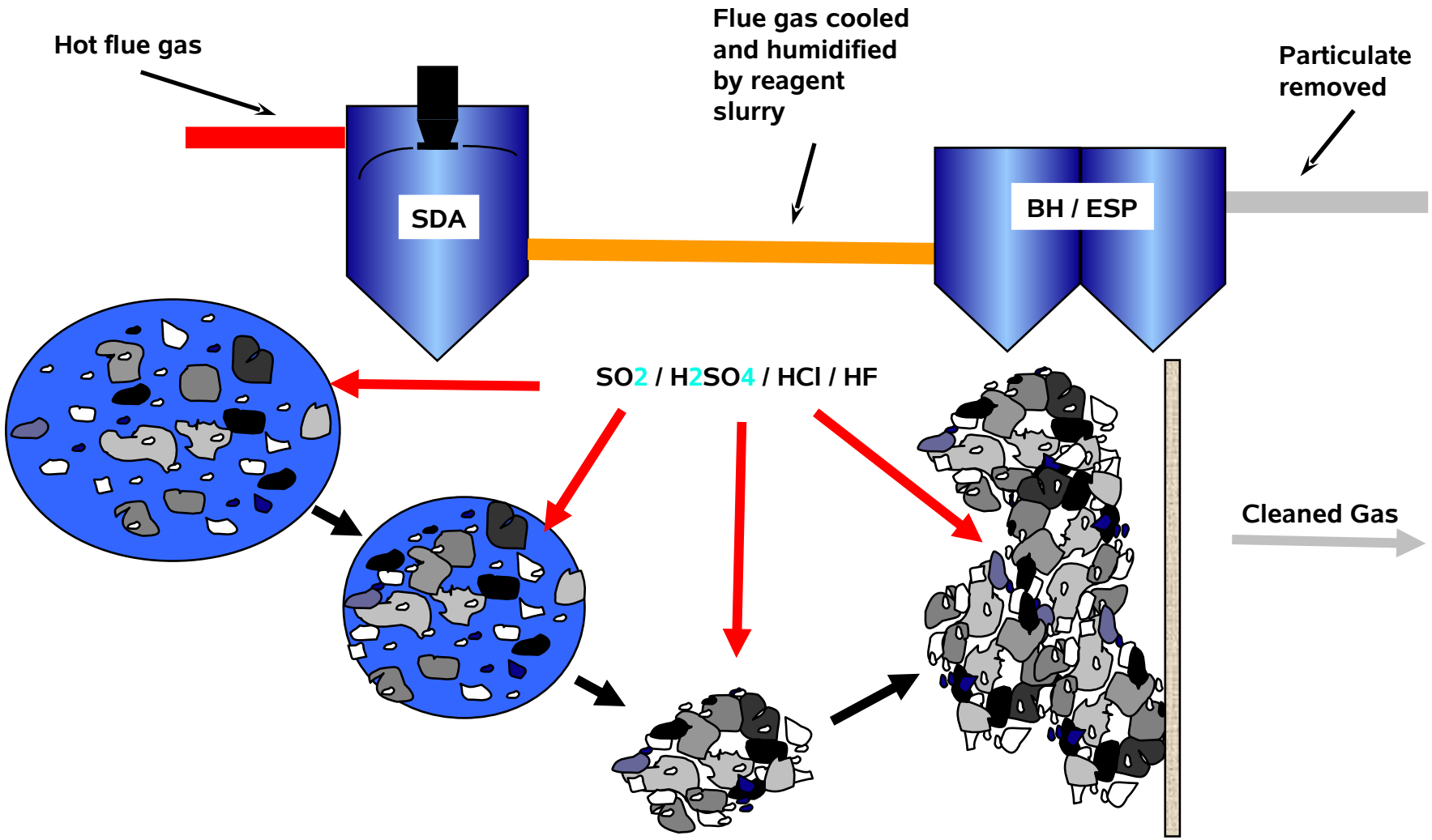






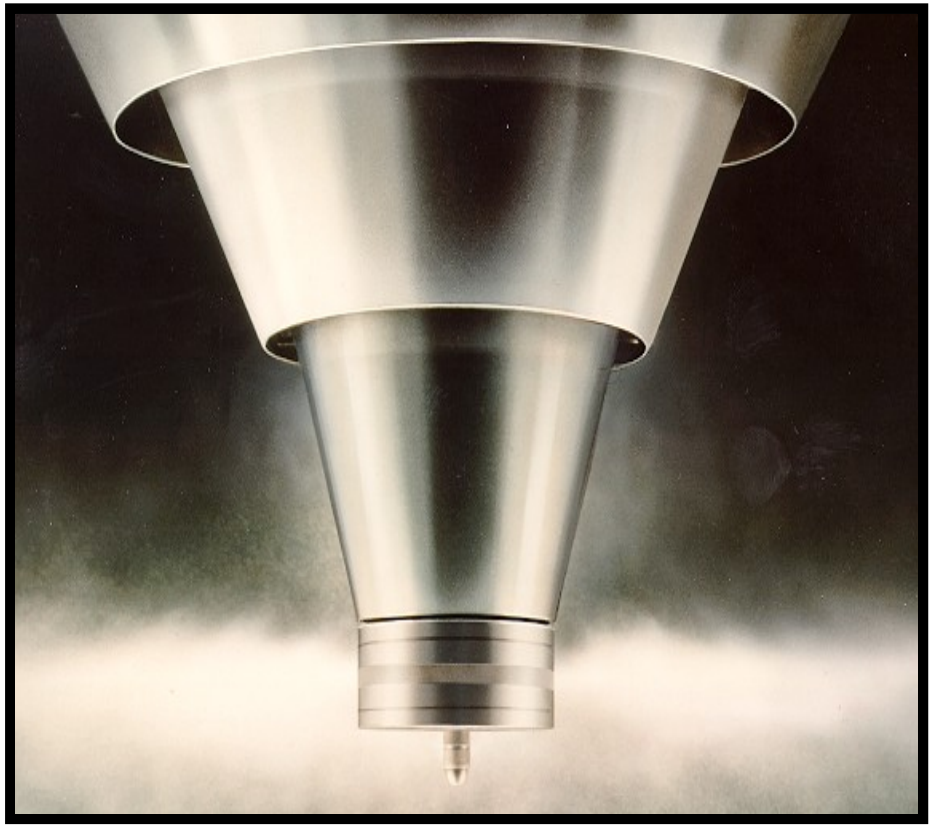
Dry FGD

Spray Dryer Absorption Process



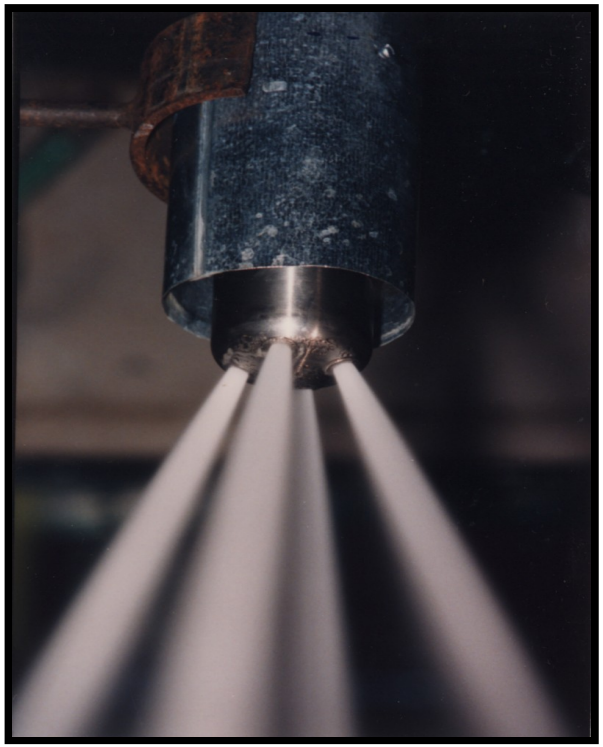
Two Stage Emissions Control Process

Slurry Atomization



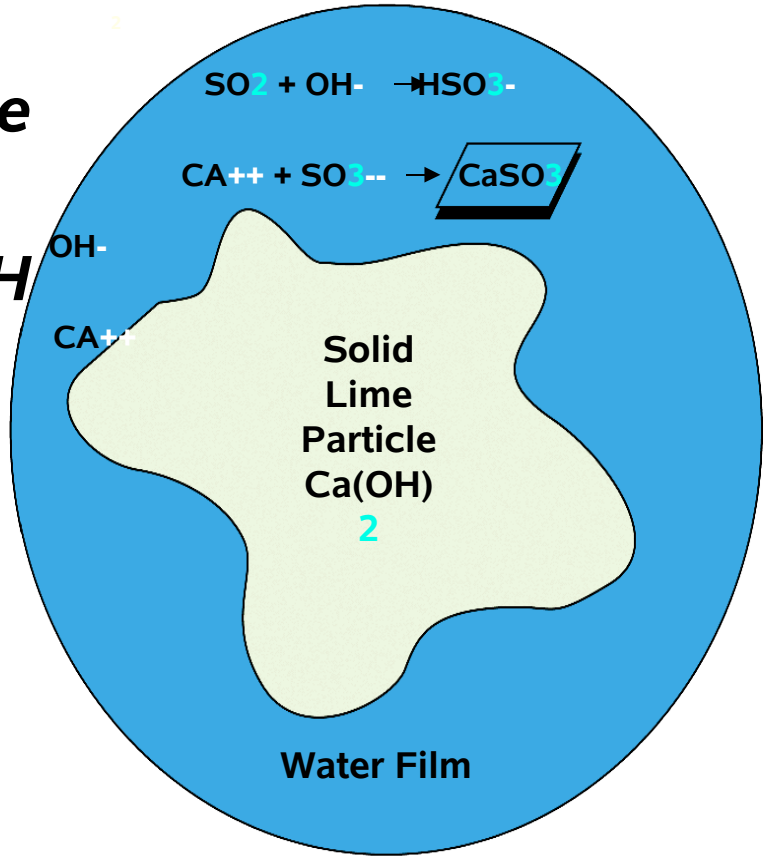
Rotary Wheel

Dual Fluid



SO_2 Absorption

- *Absorption of acid gases most rapid when water is present*
- *Dissolution rate of SO_2, reagent solubility or absorption may be rate limiting*
- *High reagent solubility and drop pH promote absorption*
- *Inert solids provide more surface area and enhance gas/reagent contact*
- *Enhanced by good distribution of high surface area reagent*



Drying

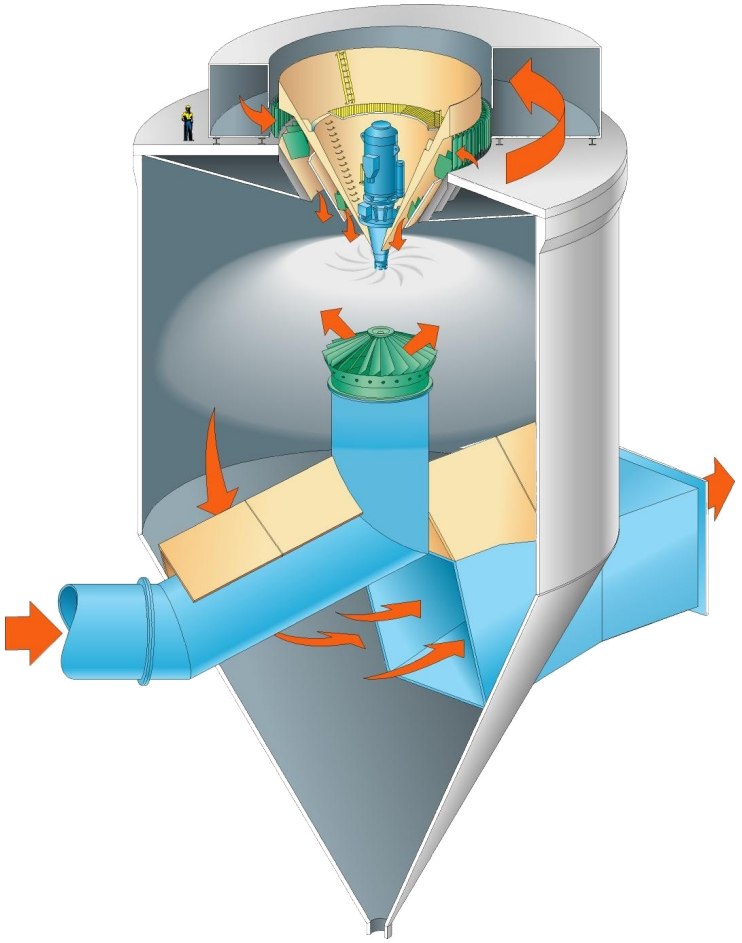
- *Initial, rapid first order drying period determined by:*
  - *Outlet temperature*
  - *Feed slurry solids loading*
  - *Drop size*
  - *Chloride content*
- *Second order drying period brings solids to final moisture content*
- *Particles / agglomerates leave SDA at 1 to 2% surface moisture*

Some Key Terminology

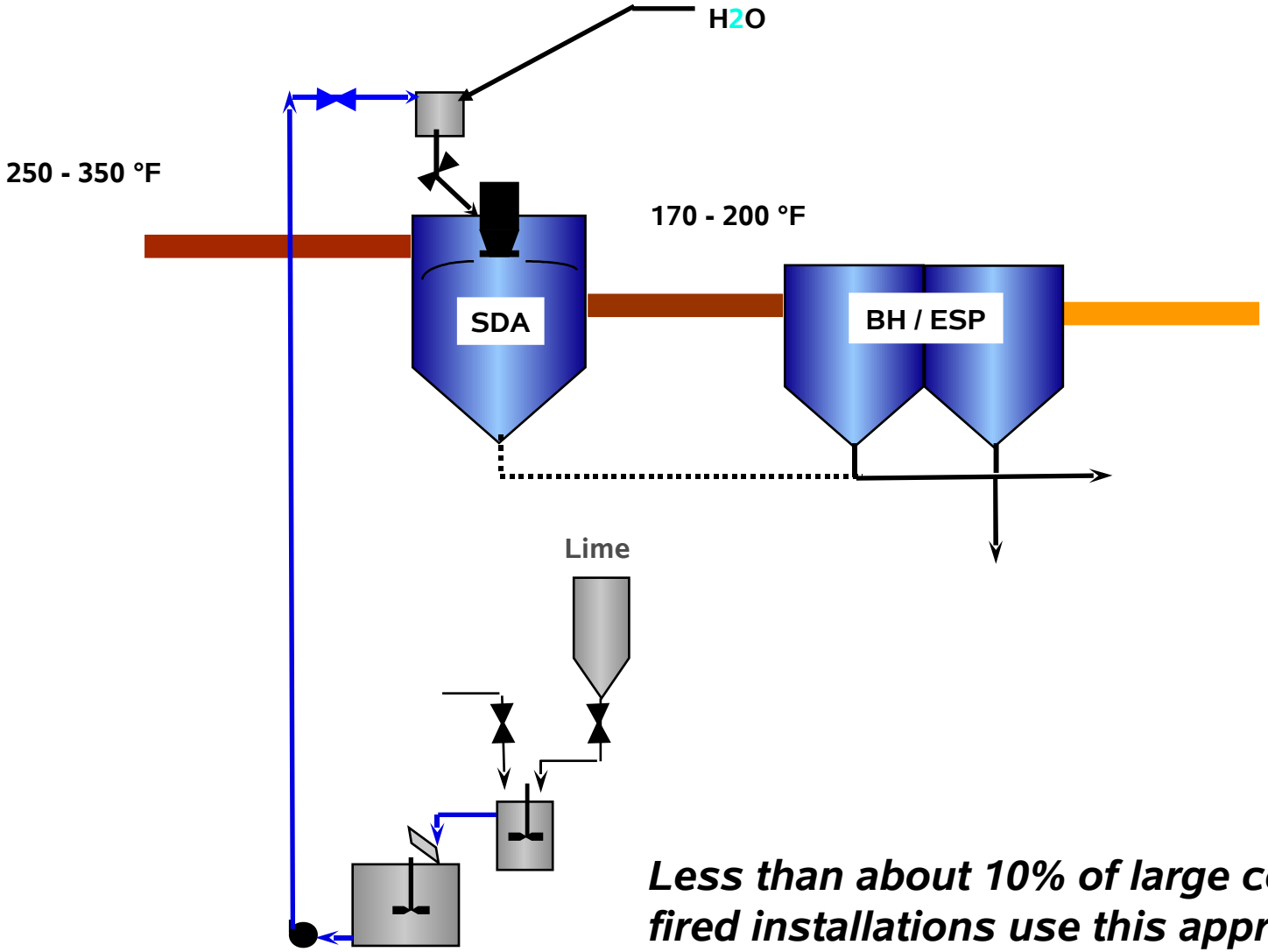
- ***Saturation Temperature***
- ***Approach to Saturation***
- ***Stoichiometry***

SDA Process Flowsheets

- *Single Pass*
- *Solids Recycle*
- *Fly Ash Pre-Collection*



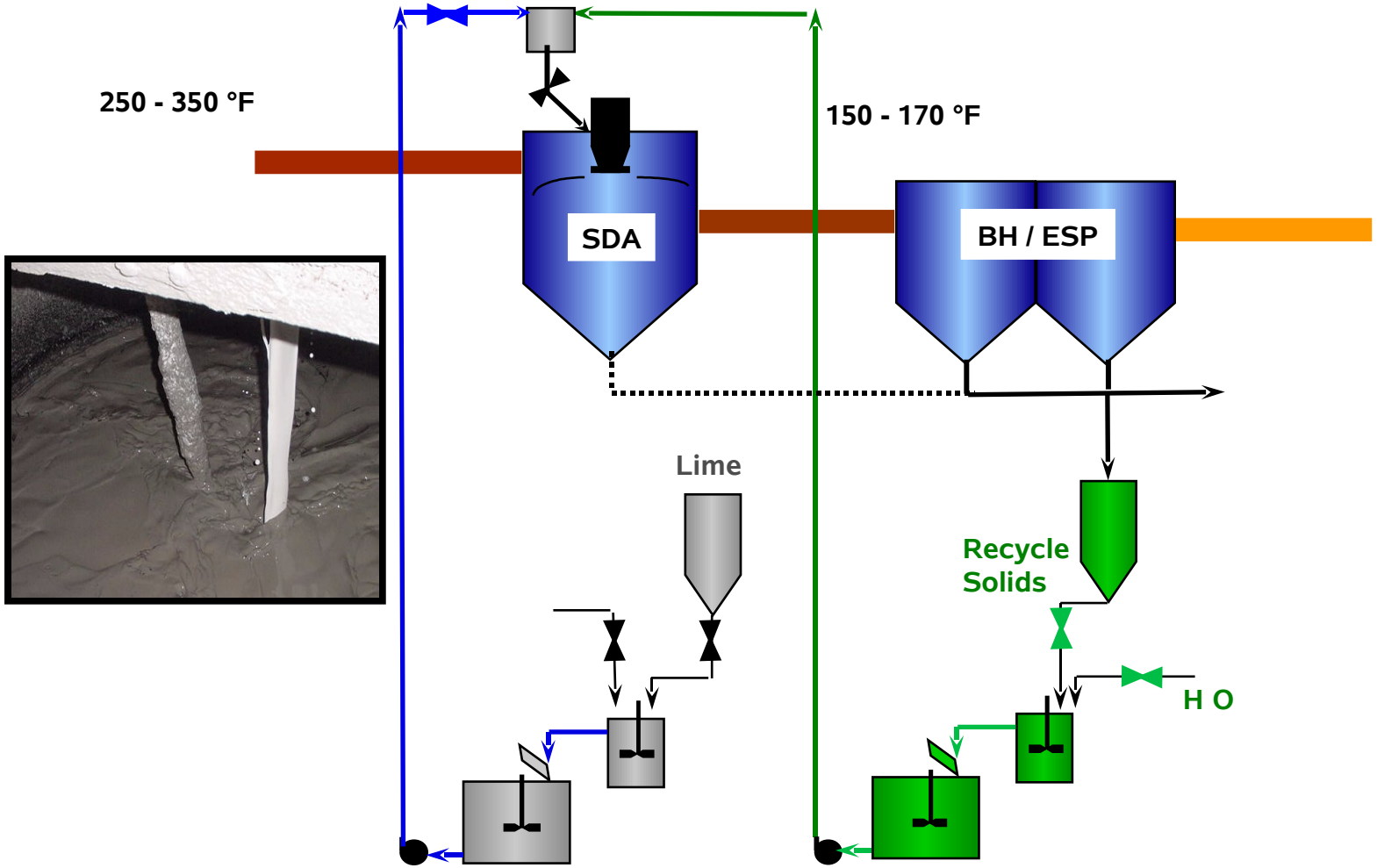
Single Pass or Lime Only



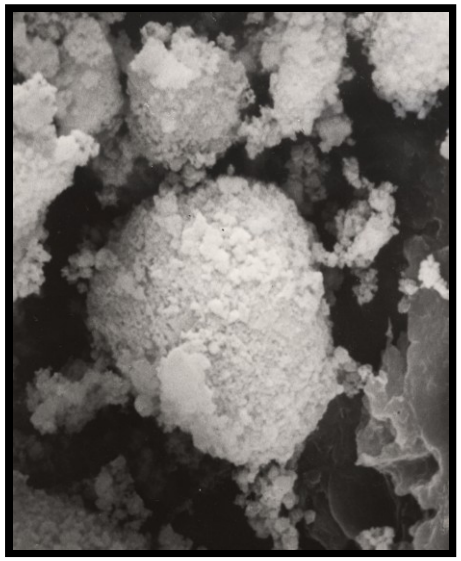
Less than about 10% of large coal-fired installations use this approach

Solids Recycle – 1980's

Solids Recycle Today

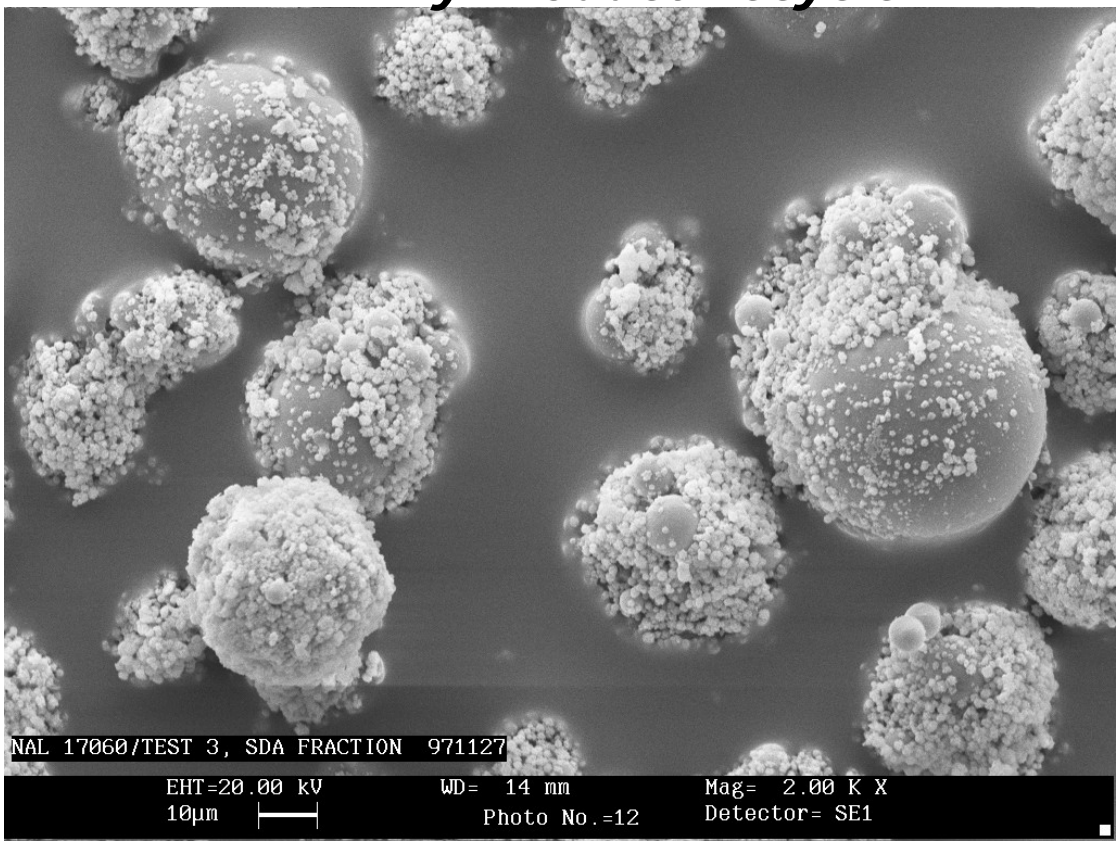


Spray Dry FGD Solids



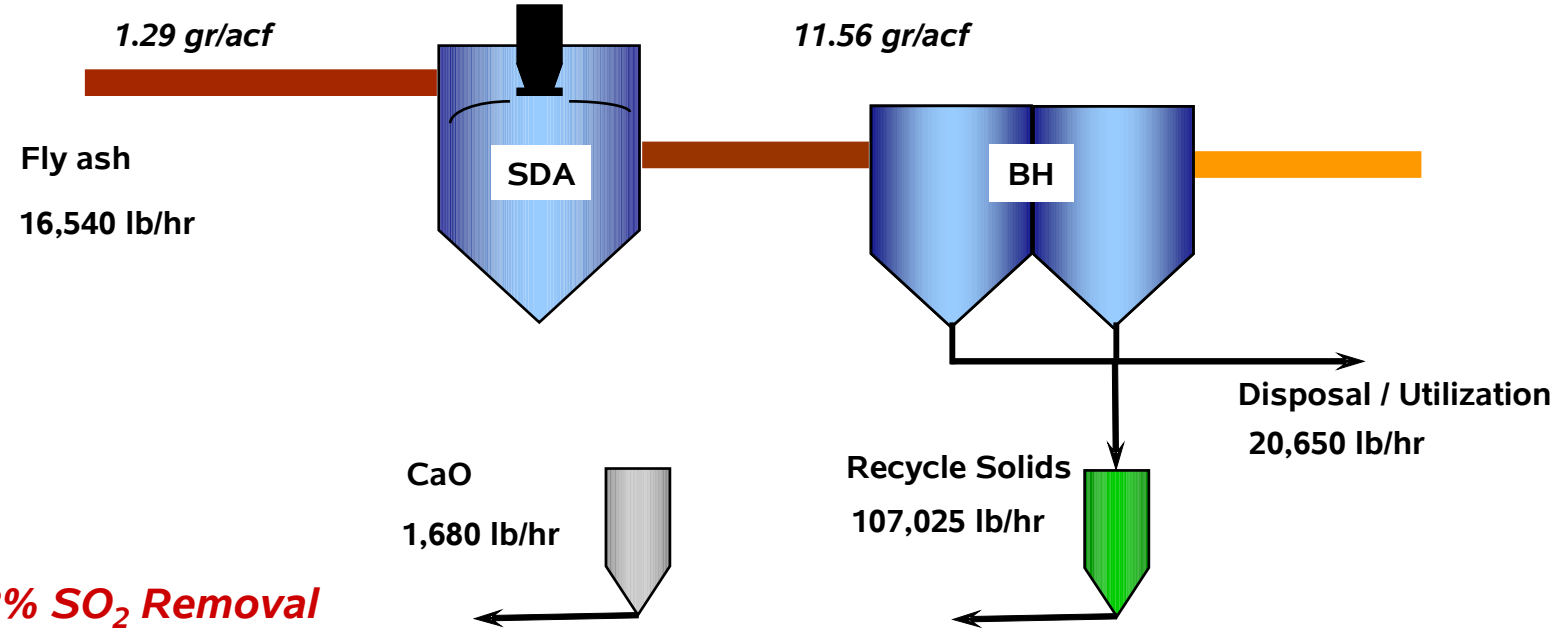
Lime Only
Single Pass

By-Product Recycle



Lime "carried" on larger fly ash particle surfaces has more readily available surface area for reaction than an agglomerate of fine lime particles.

Example Mass Balance – Sub-Bituminous Coal

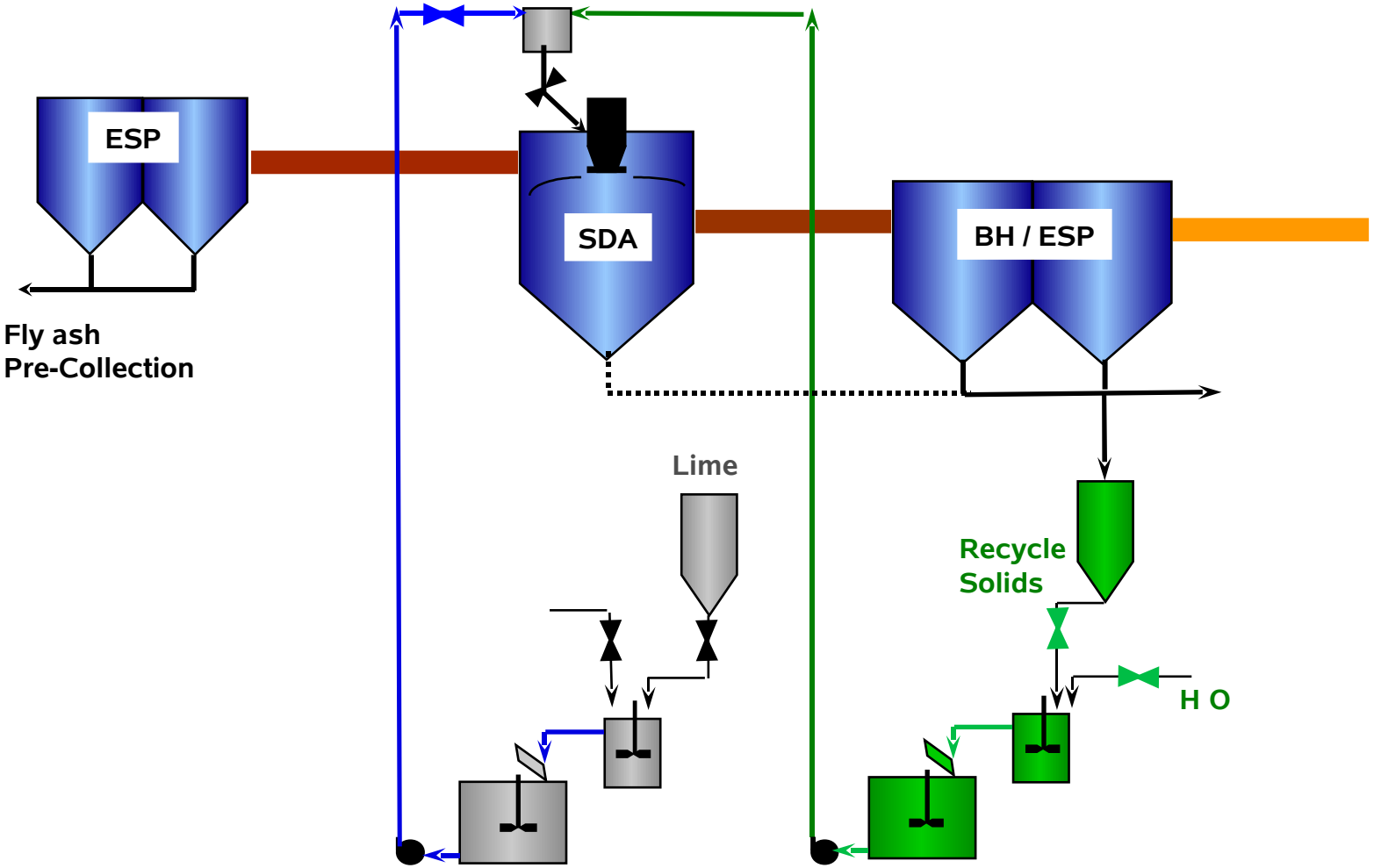


92% SO_2 Removal

By-product / Recycle Solids Composition (wt. %)

Fly Ash	79.75	Inerts	0.62
Free Water	1.00	Crystal Water	1.77
$CaSO_3$	13.25	$CaSO_4$	2.73
CaF_2	0.00	$Ca(OH)_2$	0.34
$CaCl_2$	0.16	$CaCO_3$	0.38

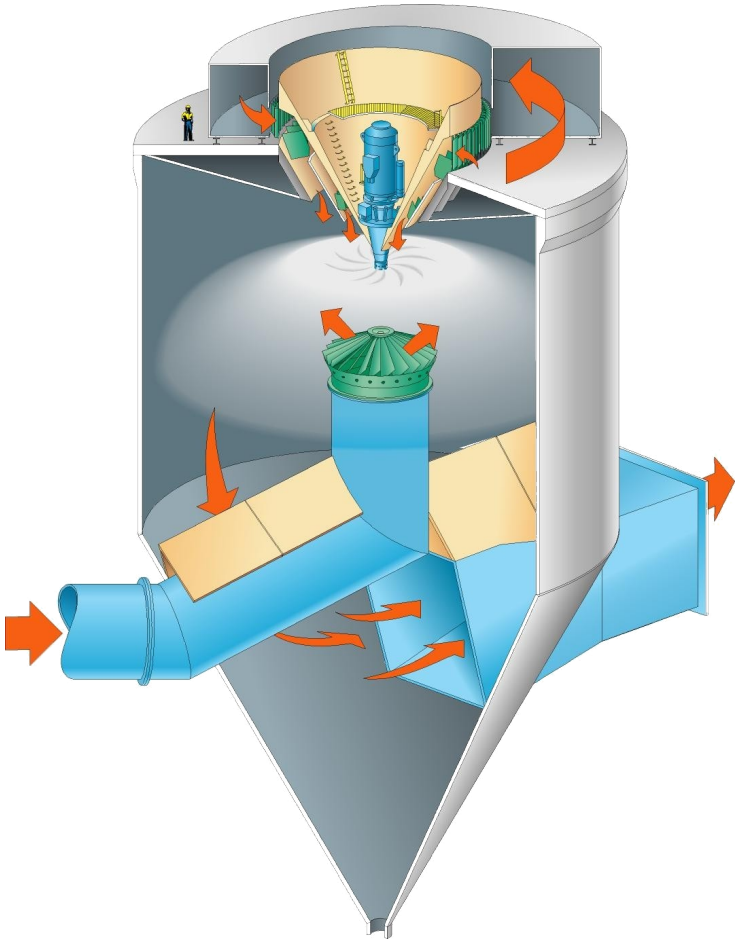
Fly Ash Pre-Collection



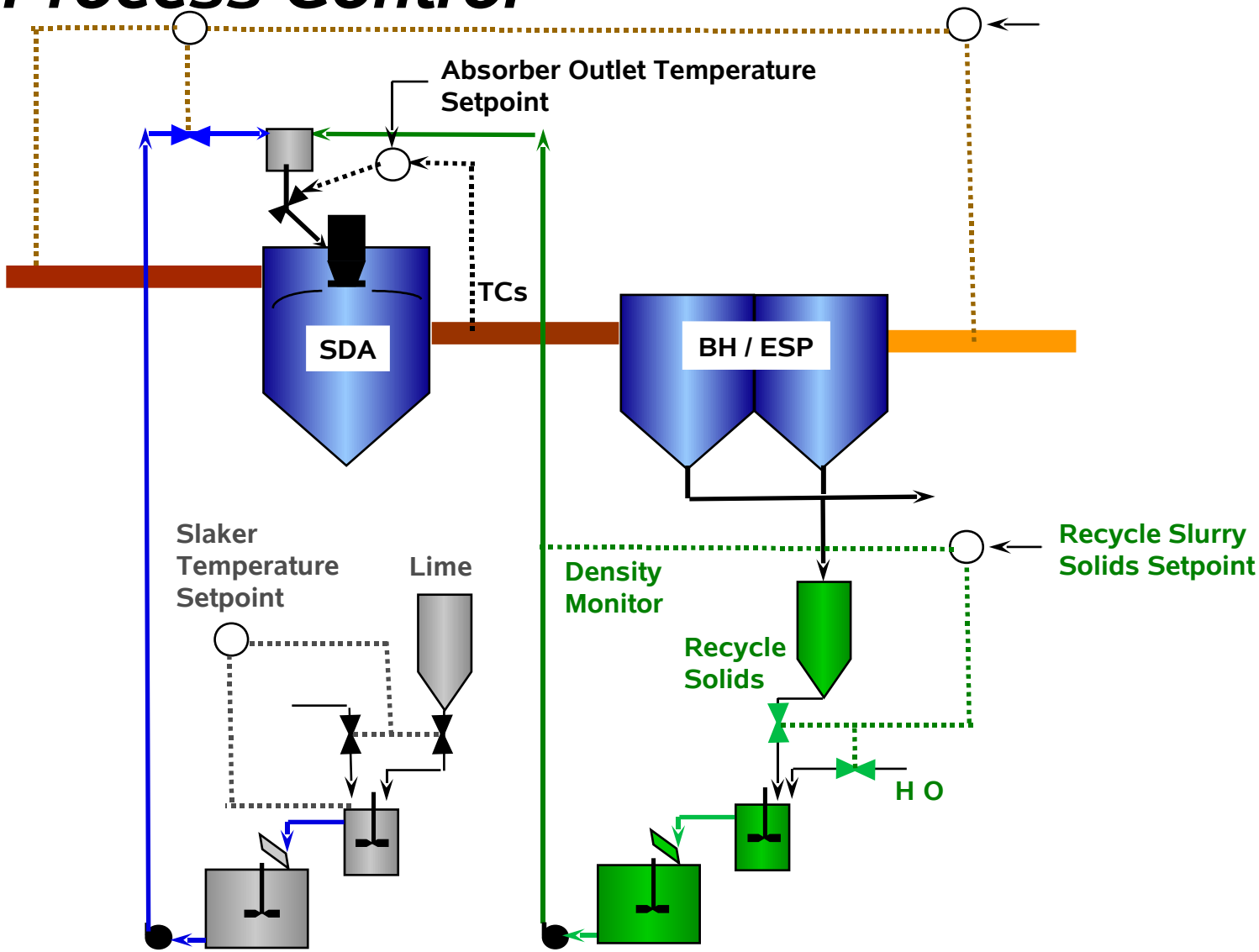
Typical European "semi-dry" FGD practice

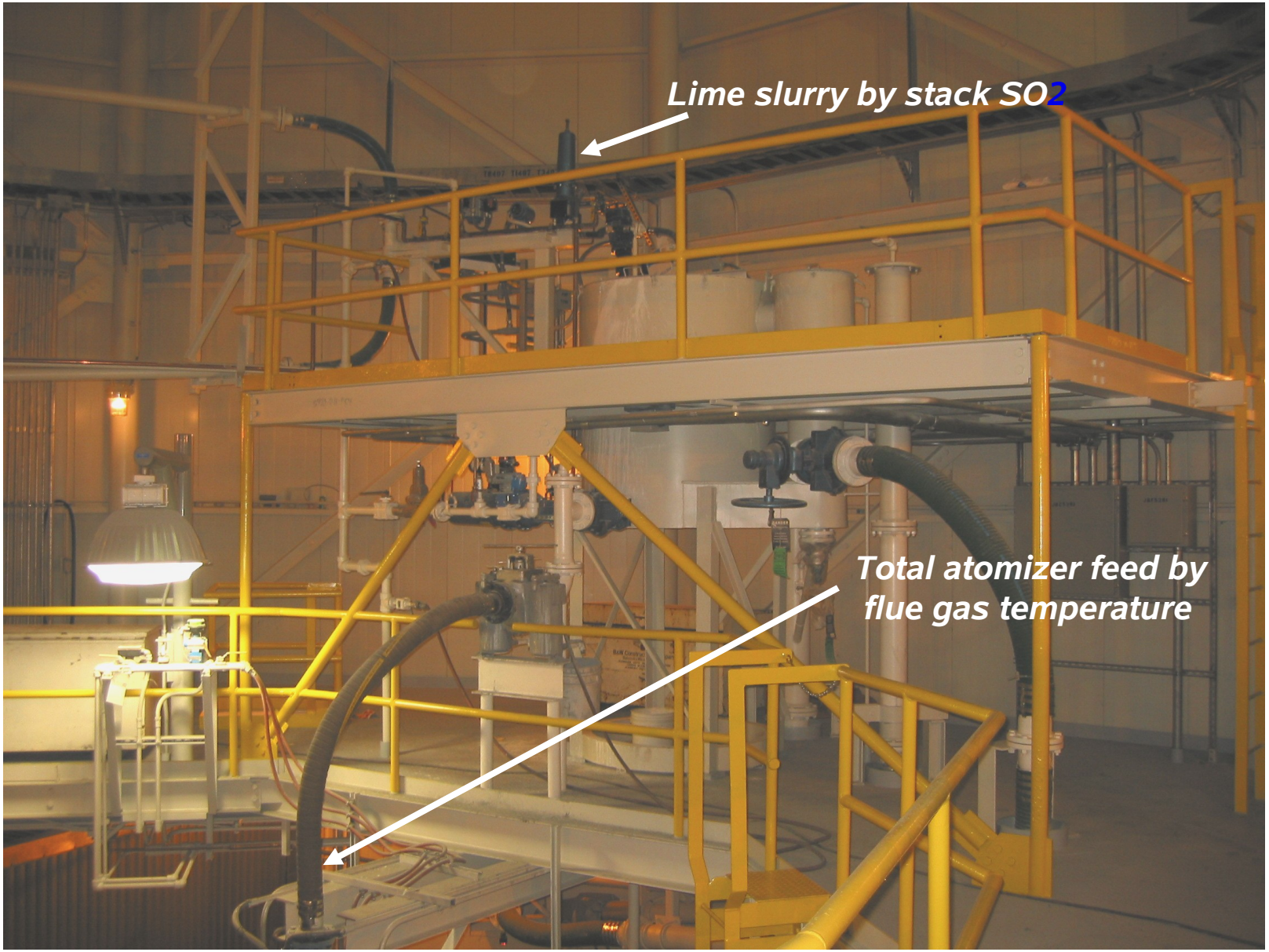
Key Operating Considerations

- Process control
- Approach temperature
- Typical design criteria
- By-product generation

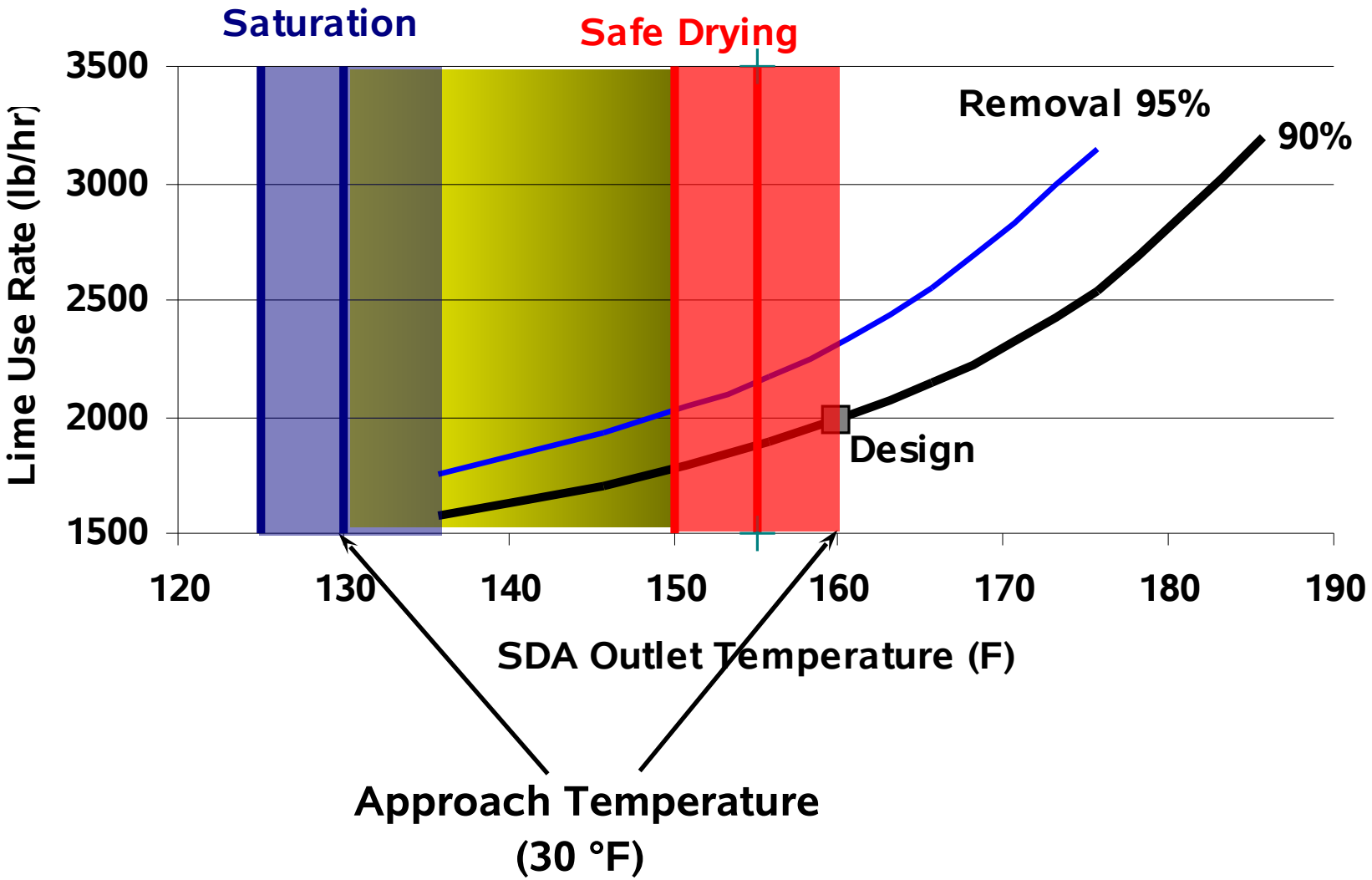


Basic Process Control

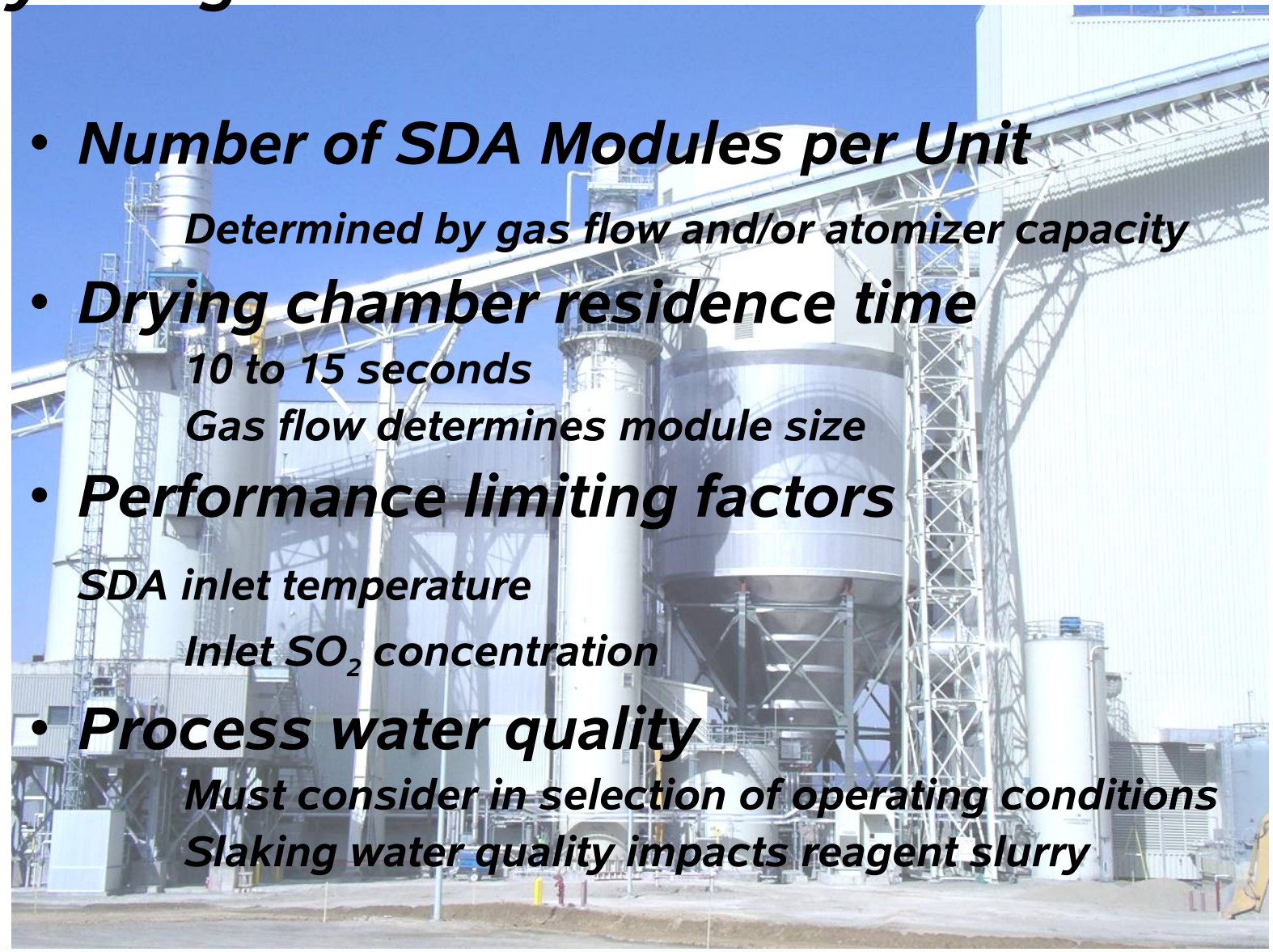




Key SDA Operation Concepts



Key Design Considerations



- **Number of SDA Modules per Unit**
  - Determined by gas flow and/or atomizer capacity
- **Drying chamber residence time**
  - 10 to 15 seconds
  - Gas flow determines module size
- **Performance limiting factors**
  - SDA inlet temperature
  - Inlet SO_2 concentration
- **Process water quality**
  - Must consider in selection of operating conditions
  - Slaking water quality impacts reagent slurry

Key Operating Considerations

- Flue gas temperature is fairly uniform throughout the SDA chamber with rotary atomizer
- SDA pressure drop typically 3 to 4 inches water
- Water use determined by gas flow and spraydown

Estimating By-Product Generation Rate

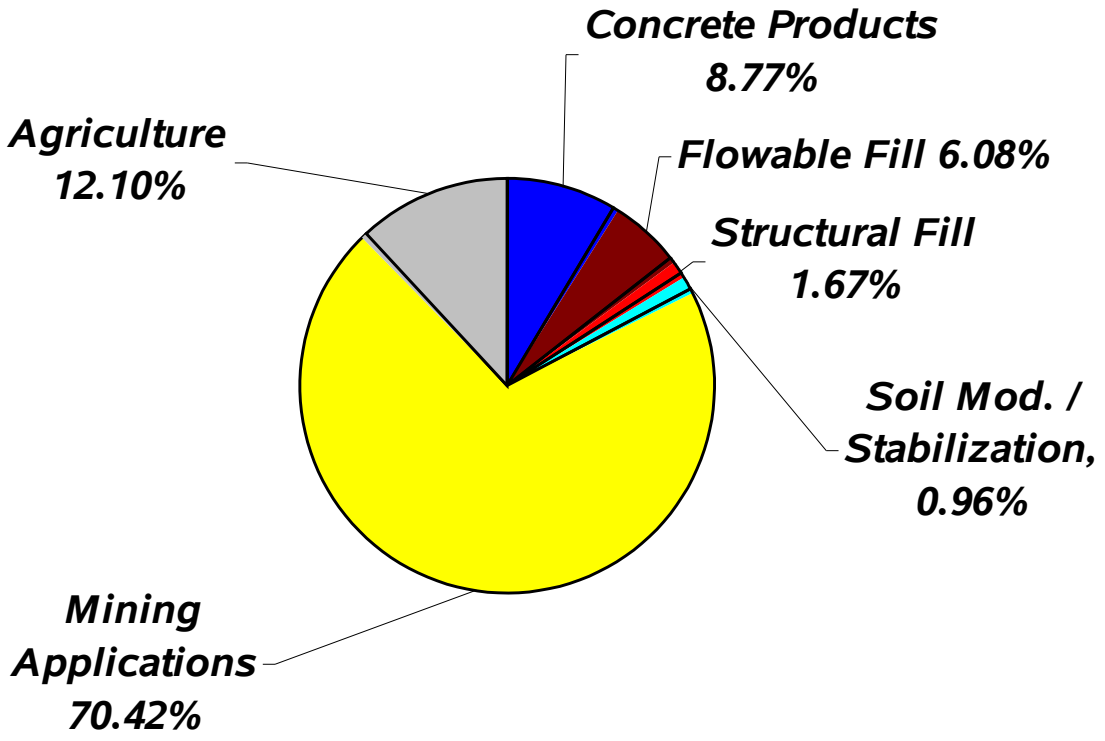
2.5 to 3.0 lb by-product solids / lb SO_2 removed

- *Excluding fly ash*
- *2.5 is good first estimate for Western coals*
  - *0.2 to 1.0 % S in coal*
- *3.0 is better estimate for Eastern coals*
  - *1.0 to 1.5 % S in coal*
- *90 to 94% SO_2 reduction*

SDA By-Product Utilization

159,198 tons put to beneficial use out of 1,427,263 tons generated (11.2%)

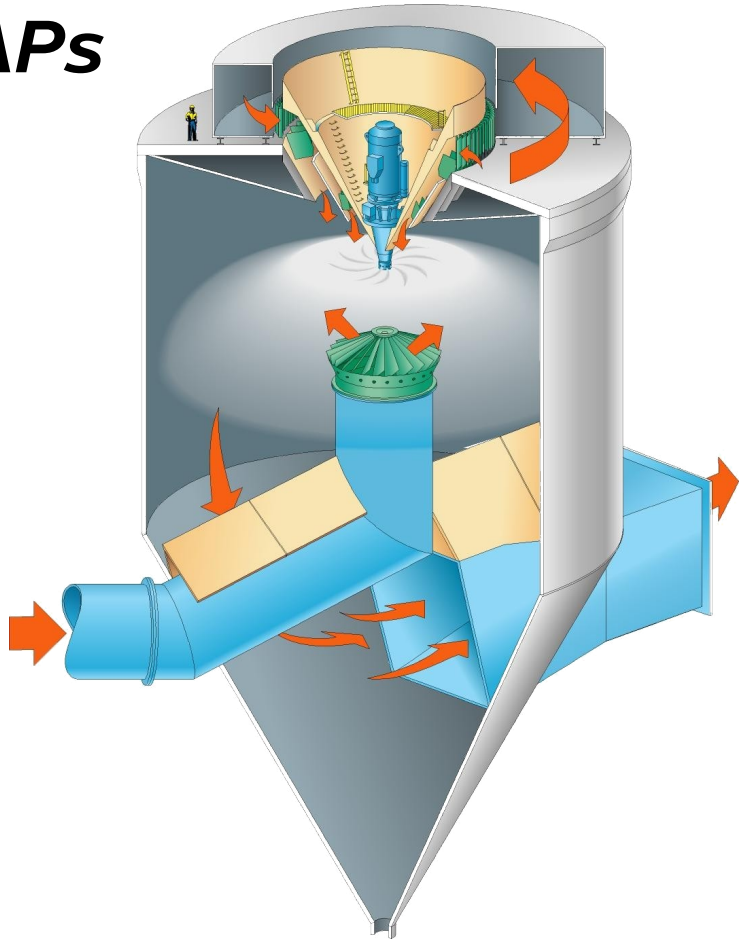
SDA By-Product Solids Use (2005)



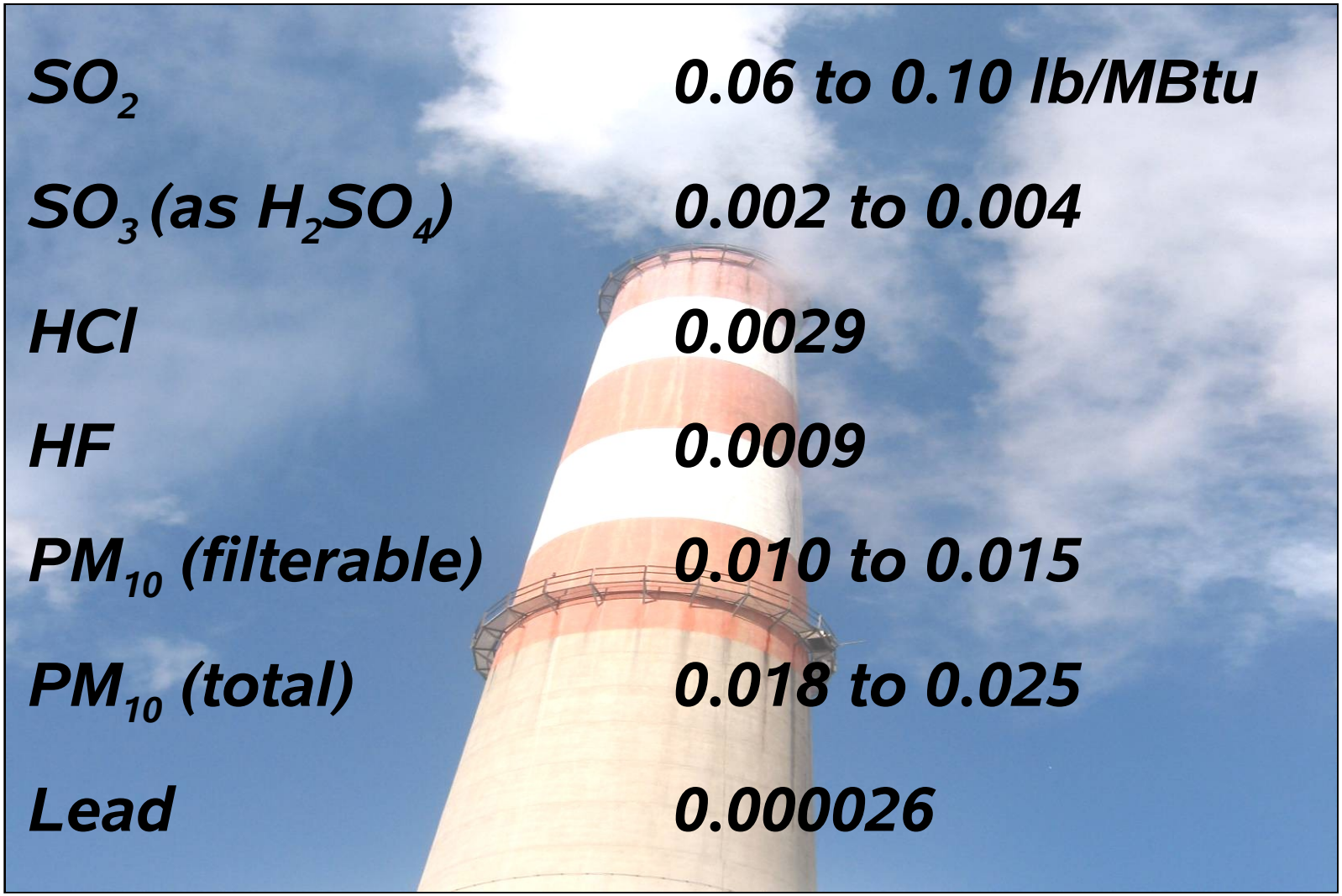
Source – American Coal Ash Association 2005 Coal Combustion Product (CCP) Production and Use Survey, www.ACAA-USA.org

Typical Performance Requirements
(in the US coal-fired utility market)

- ***Acid gas emissions and HAPs***
- ***Consumables***
- ***Reliability***



Typical SDA Emission Requirements



SO_2	0.06 to 0.10 lb/MBtu
SO_3 (as H_2SO_4)	0.002 to 0.004
HCl	0.0029
HF	0.0009
PM_{10} (filterable)	0.010 to 0.015
PM_{10} (total)	0.018 to 0.025
Lead	0.000026

Typical SDA Consumable Guarantees

- Lime Use
- Pressure Drop
- Power Consumption
- Water Use

Reliability / Availability

Typical requirement - 95 to 100%

- Usually no spare SDA module
- Reagent preparation redundancy
- Spare atomizers and pumps
- Tied to maintaining emissions

Thank You

Kevin Redinger
Technical Consultant

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Break	
Dry FGD Process Equipment	John Buschmann, Alstom Power
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Fabric Filter Fundamentals	Coni Williams, GE Energy
Open Discussion	All