Worldwide Pollution Control Association

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WPCA

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An Unbiased Comparison of FGD Technologies: Wet, Spray Dry and CDS

WPCA Conference

August 2010

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Agenda

- Introduction to FGD Technologies
- Wet FGD
- Spray Dry Absorber (SDA)
- Circulating Fluidized Bed FGD
- Compare and Contrast Technologies
- Summary

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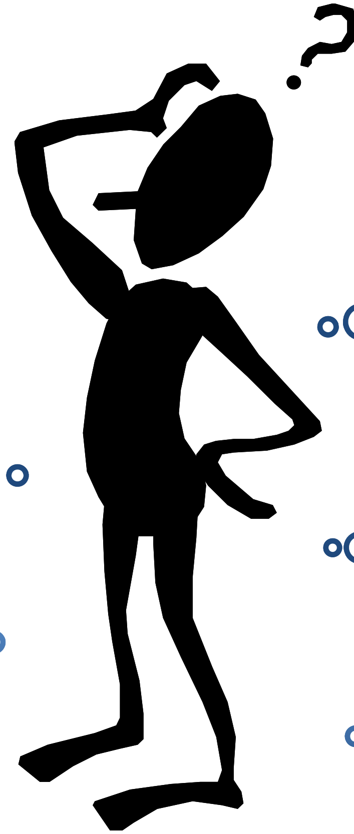
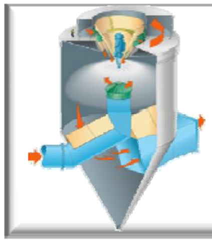
FGD Questions

- Regulations
- Availability of Absorbents
- Schedule Requirements
- Permit Requirements
- Byproduct and Waste Water Permitting
- Technology Preferences
- Design Fuel and Fuel Flexibility



Flue Gas Desulfurization and Acid Gas Control

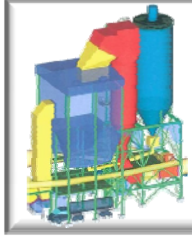


Spray Dry FGD System

- Up to 95% SO_2 removal
- Lower sulfur fuels
- Typically <1.5% sulfur coal
- Dry product for landfill
- Uses lime

Wet FGD

- Up to 98+% SO_2 removal
- High sulfur fuels (>1.5%)
- More fuel flexibility
- Marketable byproduct
- Typically uses limestone



Circulating Dry Scrubber

- Up to 98+% SO_2 removal
- Higher sulfur fuels (>1.5%)
- More fuel flexibility
- Dry product for landfill
- Uses lime which is hydrated on site

Dry Sorbent Injection

- Usually lime or sodium based
- Injected before particulate control device
- Used for SO_2,SO_3, HCl control

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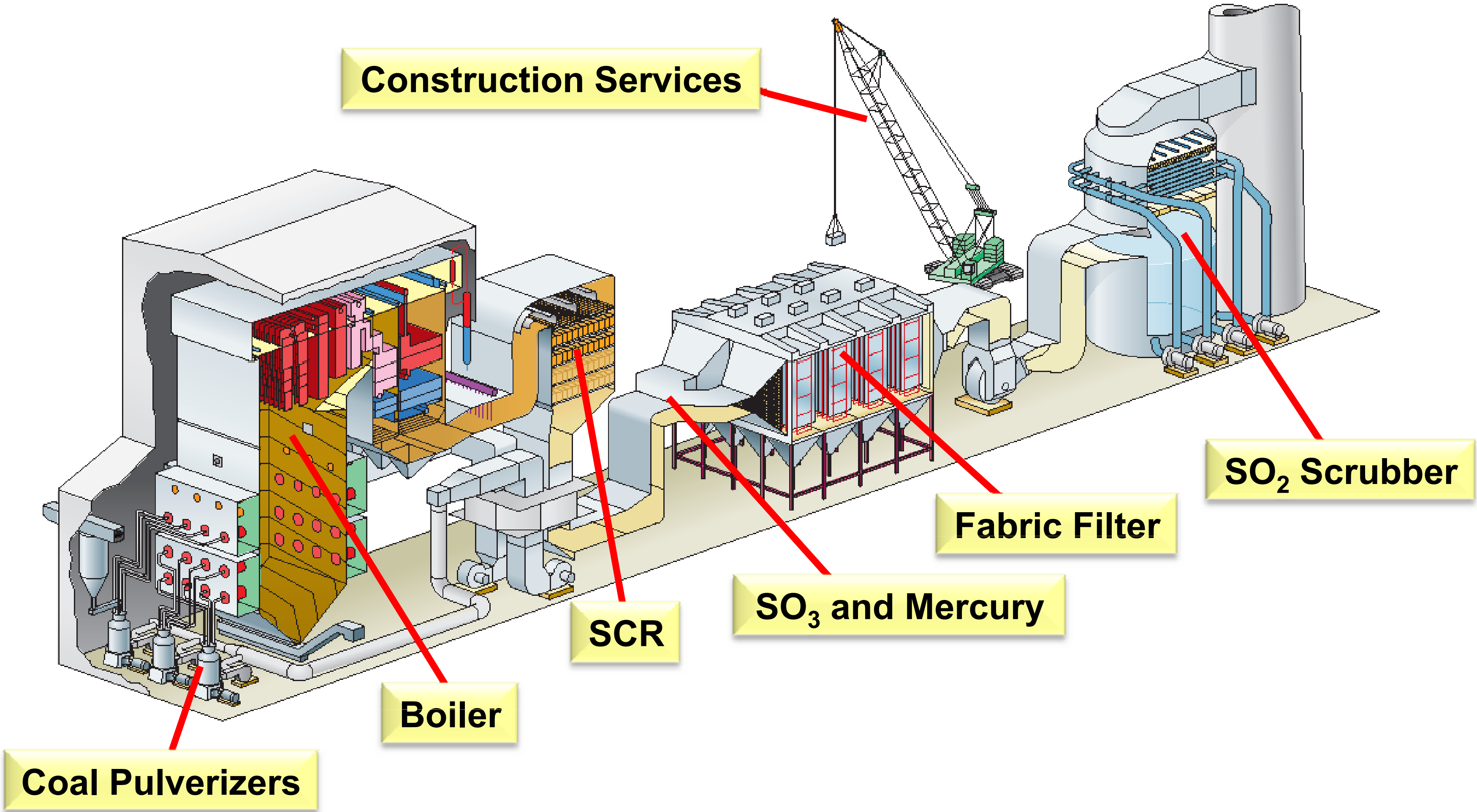
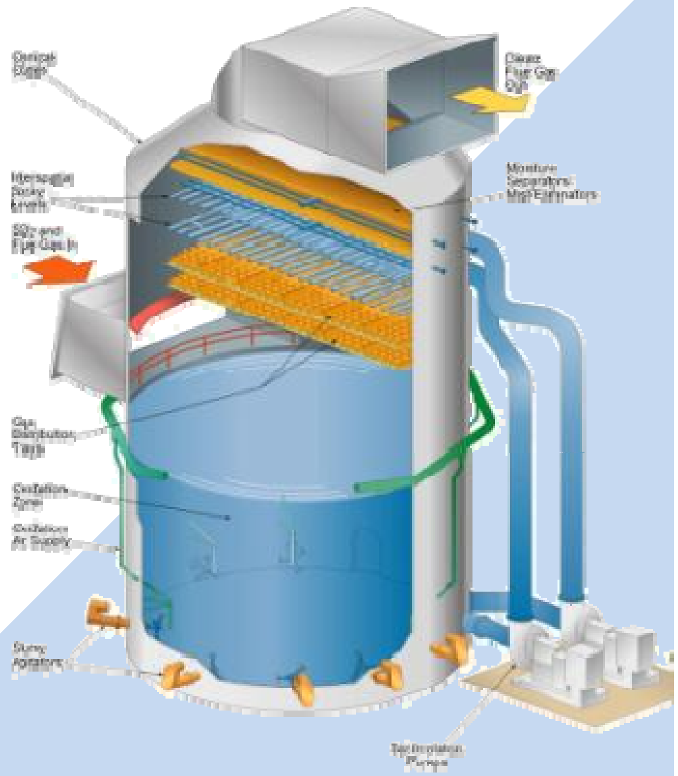
Typical Wet FGD Configuration

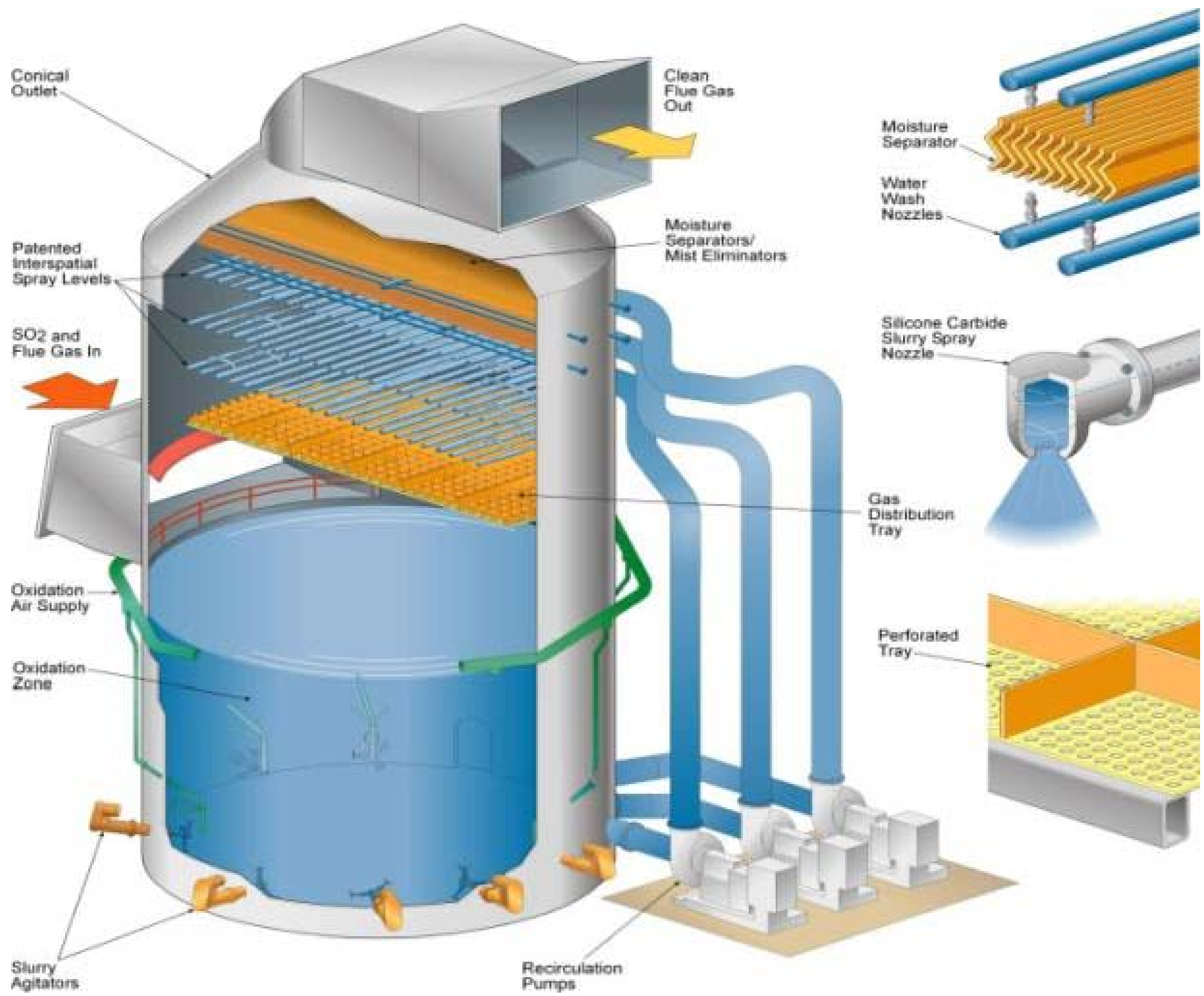


Characteristics of Wet FGD Systems

- Coal sulfur levels of 0.2 to 8%
- Inlet SO_2 ranges from 200 - 6500 ppmv
- Removal efficiencies up to 99%
- 98% removal typically required today
- Installed on ~ 60% exist US coal boilers
- Mature technology
- One tower per boiler or boilers, up to 1300 MW
- Added benefit: ability to remove oxidized mercury



Scrubber with One Tray



Advantages and Disadvantages of Wet FGD

Advantages	Disadvantages
High removal efficiency with any coal	Sampling of multiple points in process required to understand chemistry
High reagent utilization	Typically requires wastewater treatment
Excellent fuel flexibility	Alloys or coatings required for chloride protection
Mature product	High water usage
	Wet stack required

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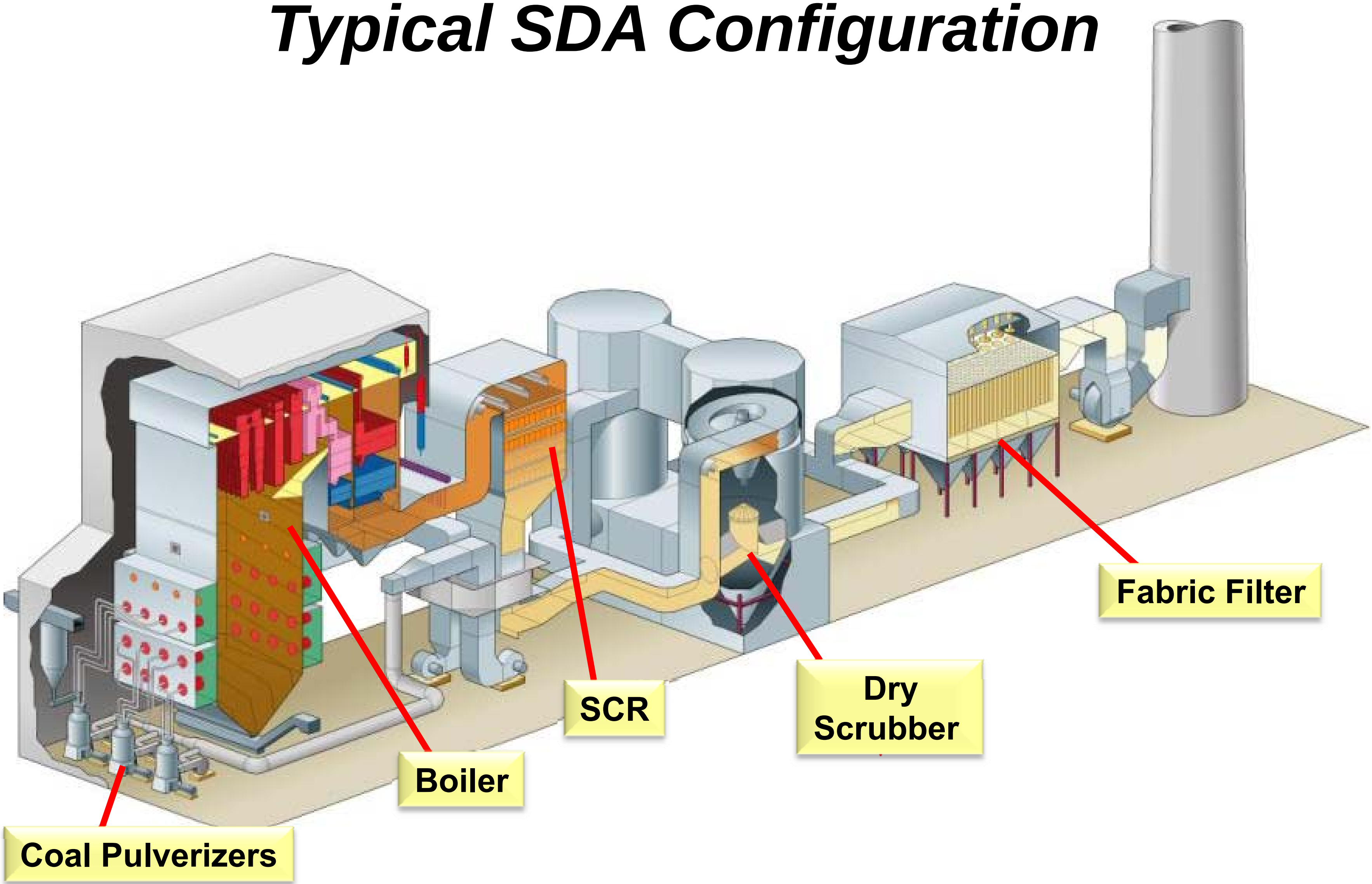
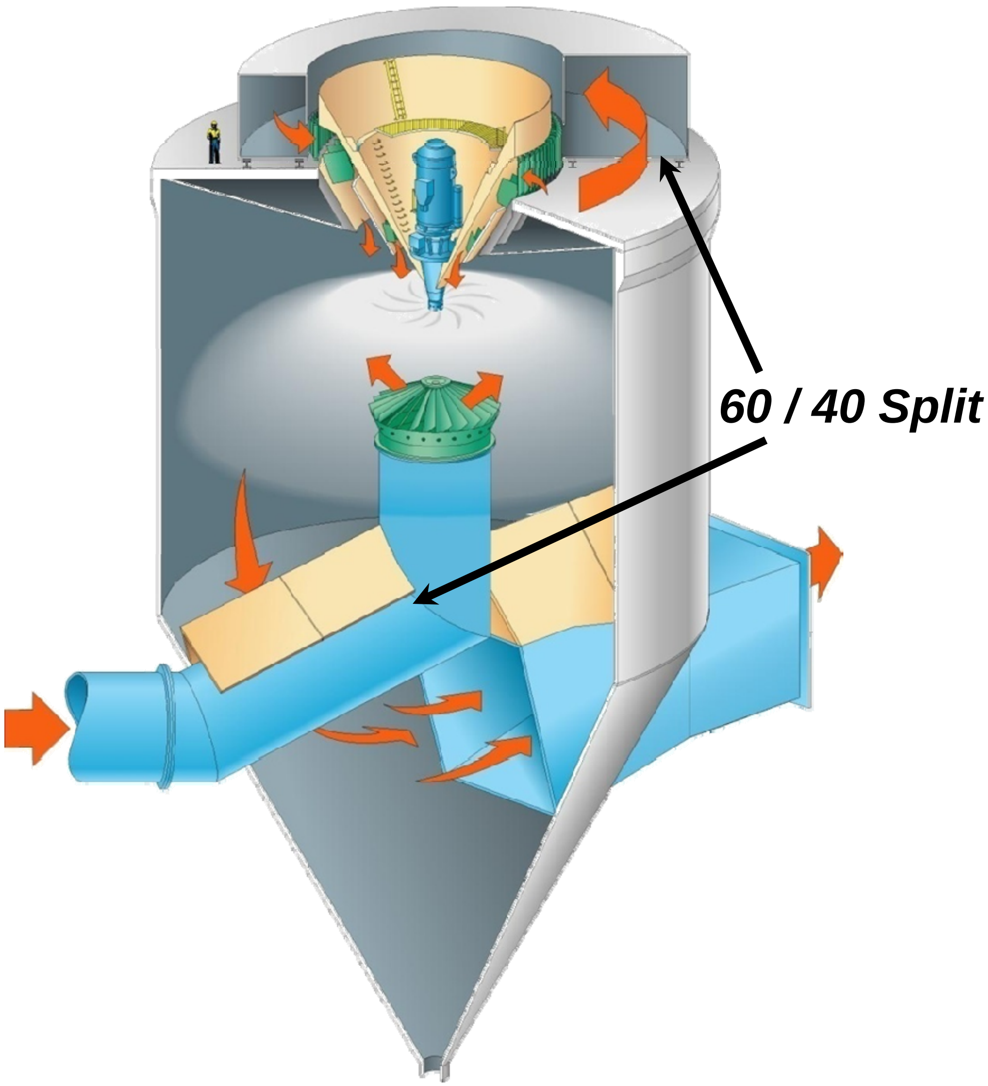
Typical SDA Configuration



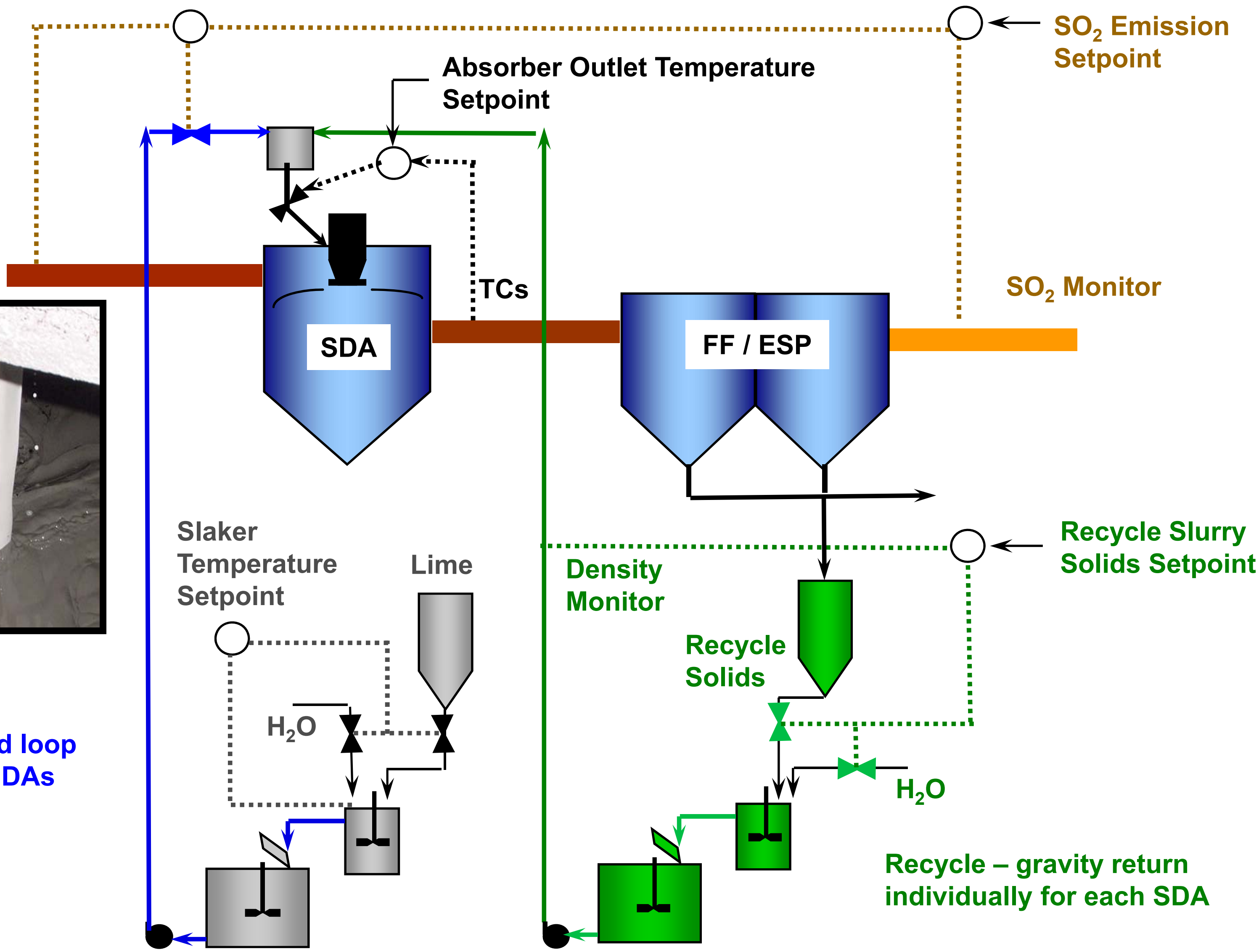
Flue Gas Distribution



Roof Gas Disperser

Central Gas Disperser

Process Flow Sheet and Control Basics



Advantages and Disadvantages of SDA

Advantages	Disadvantages
Mature product	Limited to lower sulfur coals
Recycle usage lowers lime consumption	Increased dry byproduct to dispose
Simple chemistry checks – solids in slurry	Byproduct disposal requires care
Carbon steel construction	Fairly high quality water required for slaking
Low water usage	
No wastewater treatment	
No wet stack required	

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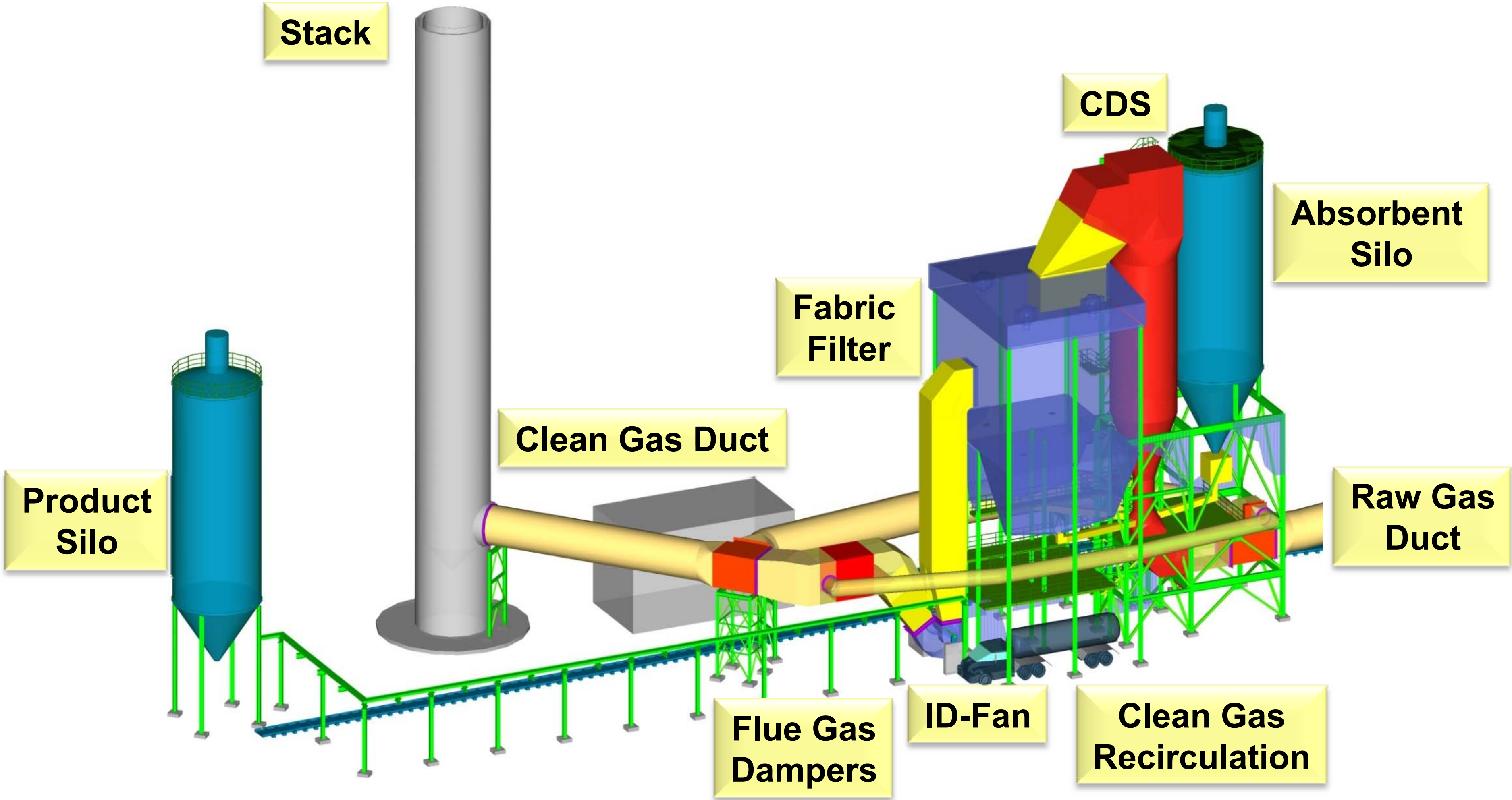
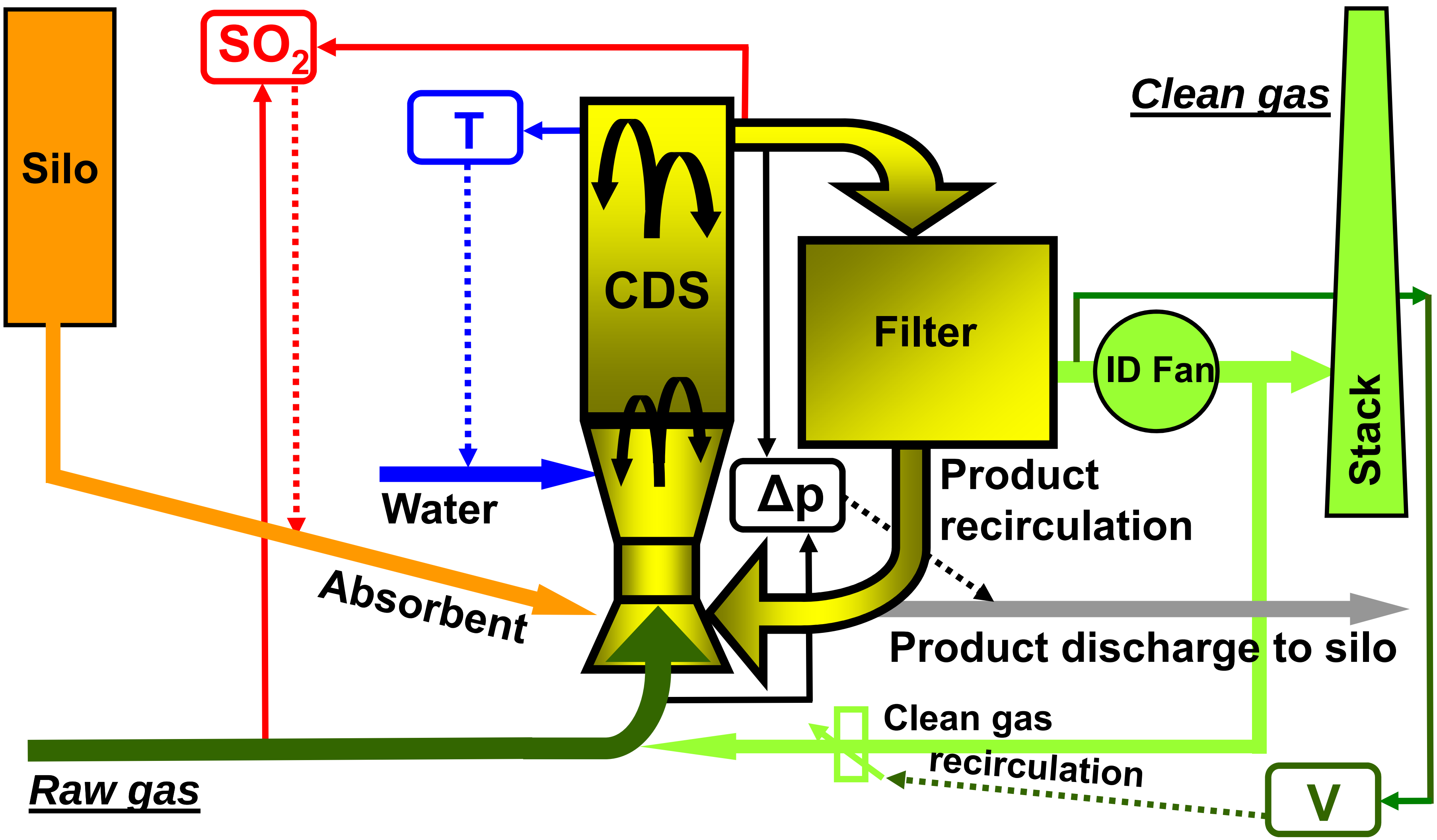
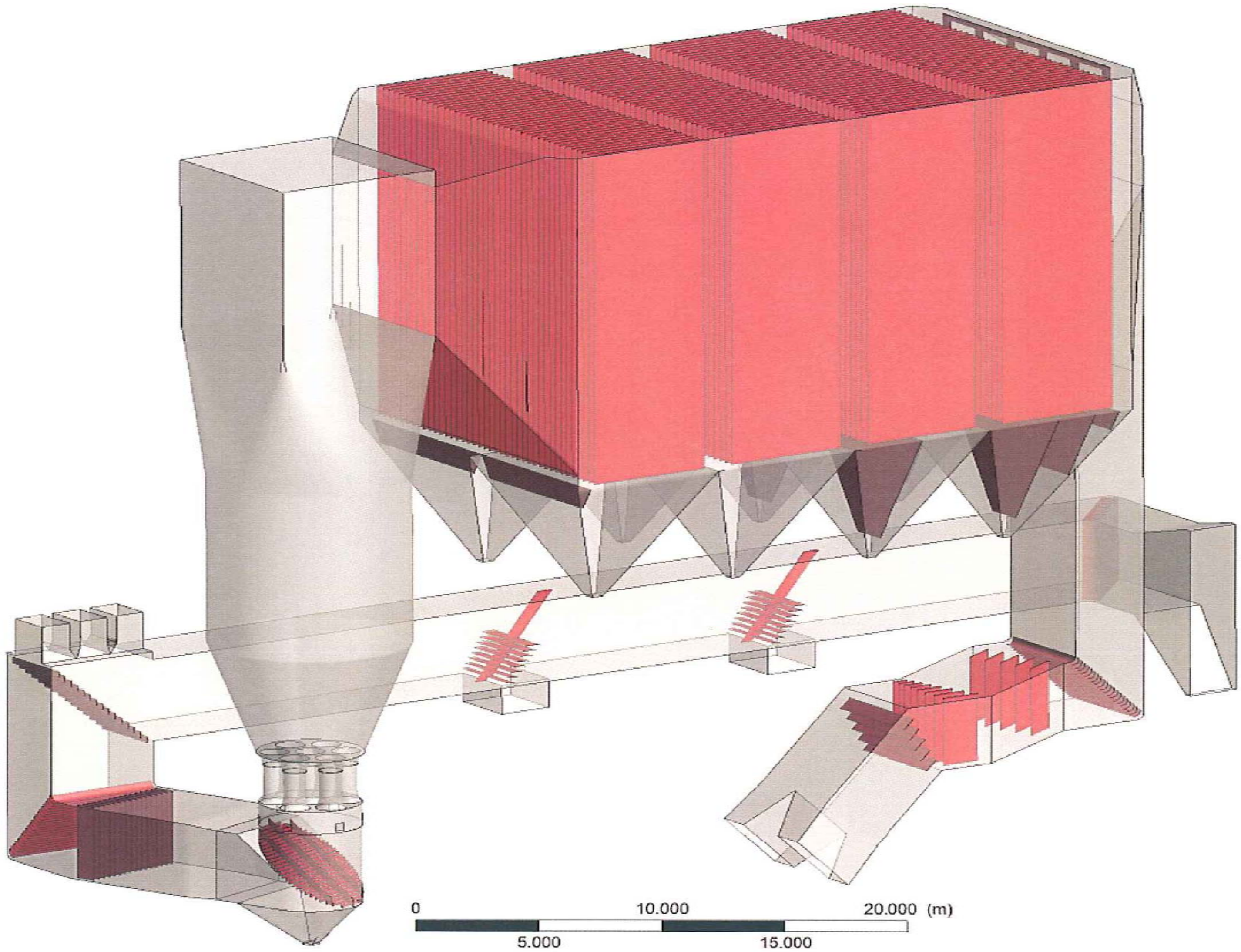
Typical CDS Arrangement



Typical Process Overview



CFD Modeling of Arrangements



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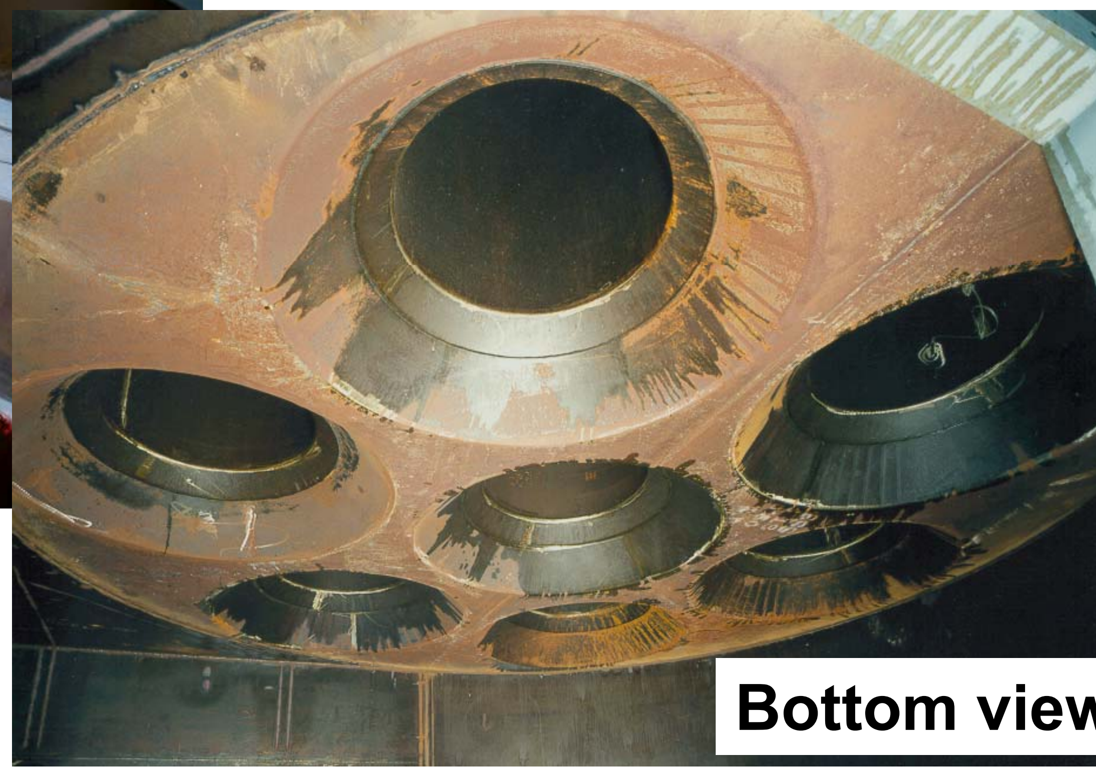
Top view



Bottom view

Water Injection

- **Lower water consumption than wet systems**
- **No saturation of clean gas**
- **High pressure injection (~600 psi)**
- **Low quality water can be used**
- **Water feed control independent from sorbent feed**

Advantages and Disadvantages of CDS

Advantages	*Disadvantages*
Water evaporation independent of sorbent feed rate	Higher pressure drop
Carbon steel construction	High pressure feedwater pumps required
Small footprint / compact plant arrangement	Byproduct transport requires care
No wastewater	Elevated baghouse
No wet stack required	

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Absorber Configurations

	Wet	*SDA*	*CDS*
Wet/Dry Interface	Inlet quench	Absorber	Absorber
Size Constraints Largest single tower (MW) Limitations	~1000	~300 atomizer	~400 bed stability
# Absorbers / Unit	Single	Multiple	Multiple
Slurry pH	5 - 6	11 - 12	N/A
Chlorides	High	Low	Low
Flue Gas	Saturated	Above Saturation	Above Saturation

Material of Construction

	Wet	SDA	CDS
Absorber Tower	Alloy Tile Fiberglass	Carbon Steel	Carbon Steel
Nozzles / Atomizers	Ceramic	Alloy / Ceramic	CS venturis/ ceramic water
Flues	Lined	Carbon Steel Coatings	Carbon Steel Coatings

Reagents

	Wet	*SDA*	*CDS*
Stoichiometry	↓	↑	↑↑
Type	**Limestone ($CaCO_3$) Lime Sodium**	**Lime (CaO) Fly Ash**	**Lime (CaO) Fly Ash**
Typical Cost	**$5 - 25/ton**	**$60 - 120/ton**	**$60 – 120/ton**
Preparation	**Wet grinding**	**Grinding Slaking**	**Hydration**

By-Product Streams

	Wet	*SDA*	*CDS*
Solids			
Composition	$CaSO_4$	Fly ash $CaSO_3$ $CaSO_4$ $CaCl_2$	Fly ash $CaSO_3$ $CaSO_4$ $CaCl_2$
Beneficial Uses	Gypsum Wall-board Cement additive	Aggregate Mine reclaim Cement	Aggregate Mine reclaim Cement
Landfill	Dry / pond	Dry	Dry
Water	Treatment	None	None

Economics

	Wet	SDA	CDS
Capital Costs	↑↑	↓	↑
Reagent Usage	↓	↑	↑↑
Power Usage	↑↑	↓	↑

Lifecycle Economics

	Wet	*SDA*	*CDS*
Eastern Mid-High Sulfur Fuel with high removal requirements, <~400MW	↑↑	**Typically N/A**	↓
Eastern Mid-High Sulfur Fuel with high removal requirements, >~400MW	↓	**Typically N/A**	↑↑
Western Fuels	↑↑	↓	↑

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Summary of Wet, Spray Dry and CDS FGD

Wet FGD	Spray Dryer	CDS
Typically, **the lower lifecycle cost for larger units burning high S coal and requiring high SO_2 removal**	***Typically,*** **the lowest lifecycle costs if required SO_2 removal is achievable**	***Typically,*** **the lower lifecycle cost for smaller units burning high S coal and requiring high SO_2 removal**

Thank You.