Worldwide Pollution Control Association

WPCA-Duke Energy

Is Your Precipitator Ready for MATS?

Aug. 28, 2012 – Plainfield

Sept. 11, 2012 - Charlotte

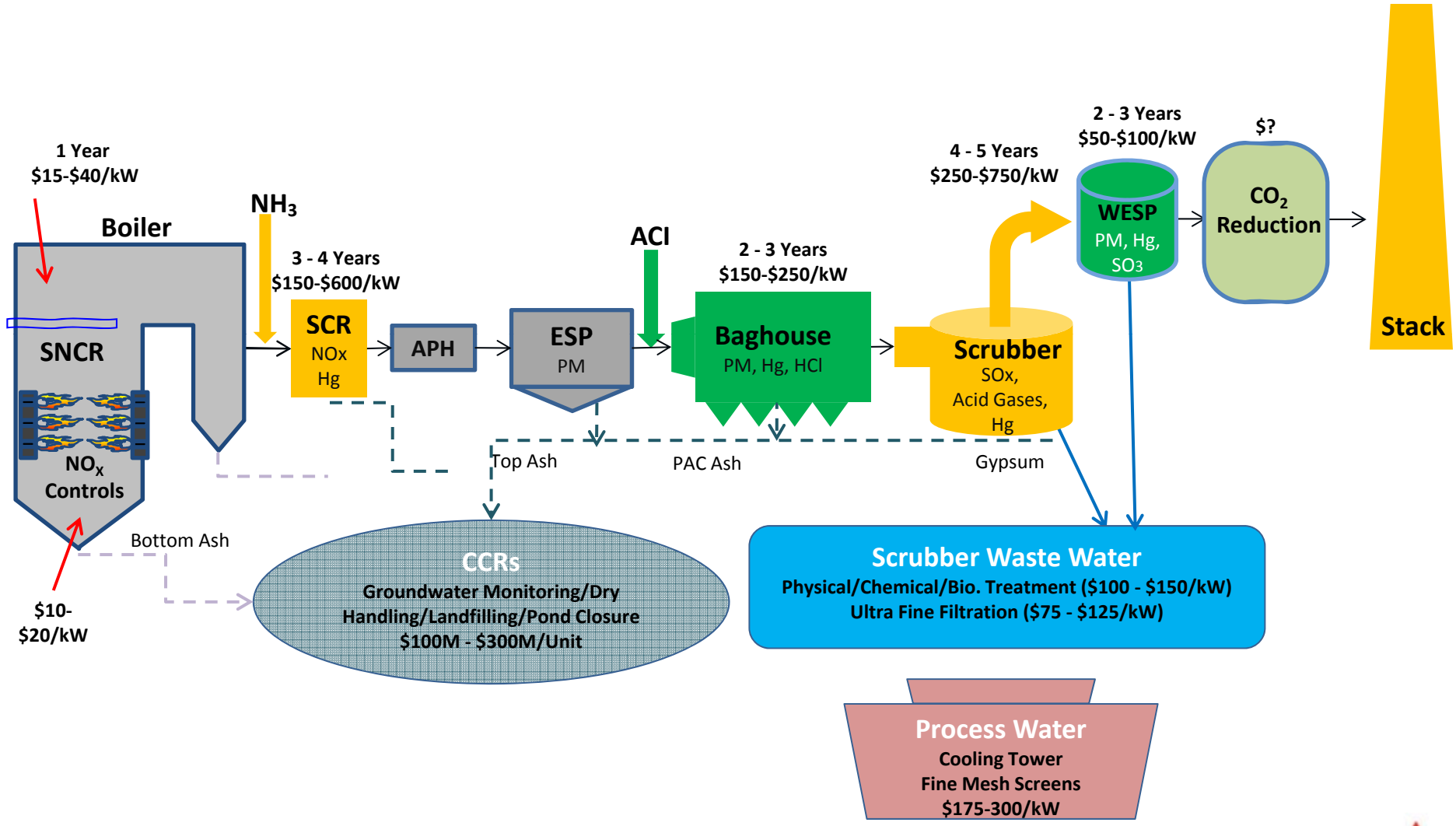
Visit our website at www.wpca.info

Mercury Basics

Mark S. Berry, PE

Research & Technology Management

A “Controlled” Future



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Mercury & Air Toxics (MATS) Limits

Emission Standards for Existing Coal-Fired Power Plants

Pollutant	Input Base Limit	Output Based Limit
Mercury	**1.2 lb x 10^{12} (TBtu)**	**0.013 lb / GWhr**
Filterable PM	0.03 lb x 10^{6} Btu (MMBtu)	0.30 lb / MWhr
HCl / SO2	0.002 x 10^{6} Btu or 0.2 x 10^{6} Btu (MMBtu)	0.02 lb / MWhr or 1.5 lb / MWhr

Emission Standards for New Coal-Fired Power Plants

Pollutant		Boilers	
Mercury		**0.0002 lb / GWhr**	
Filterable PM		0.0070 lb / MWhr	
HCl / SO2		0.40 lb / GWhr or 0.4 lb / GWhr	

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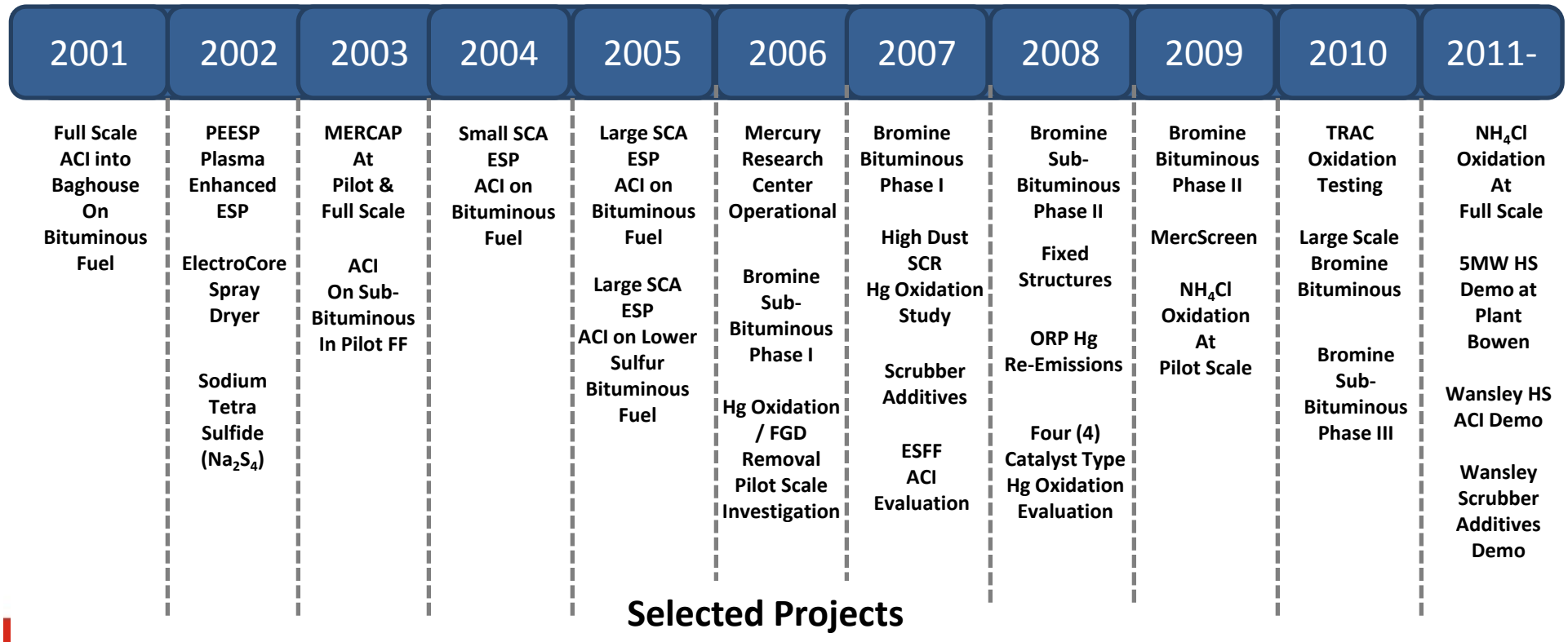
Southern Company Mercury R&D Activities

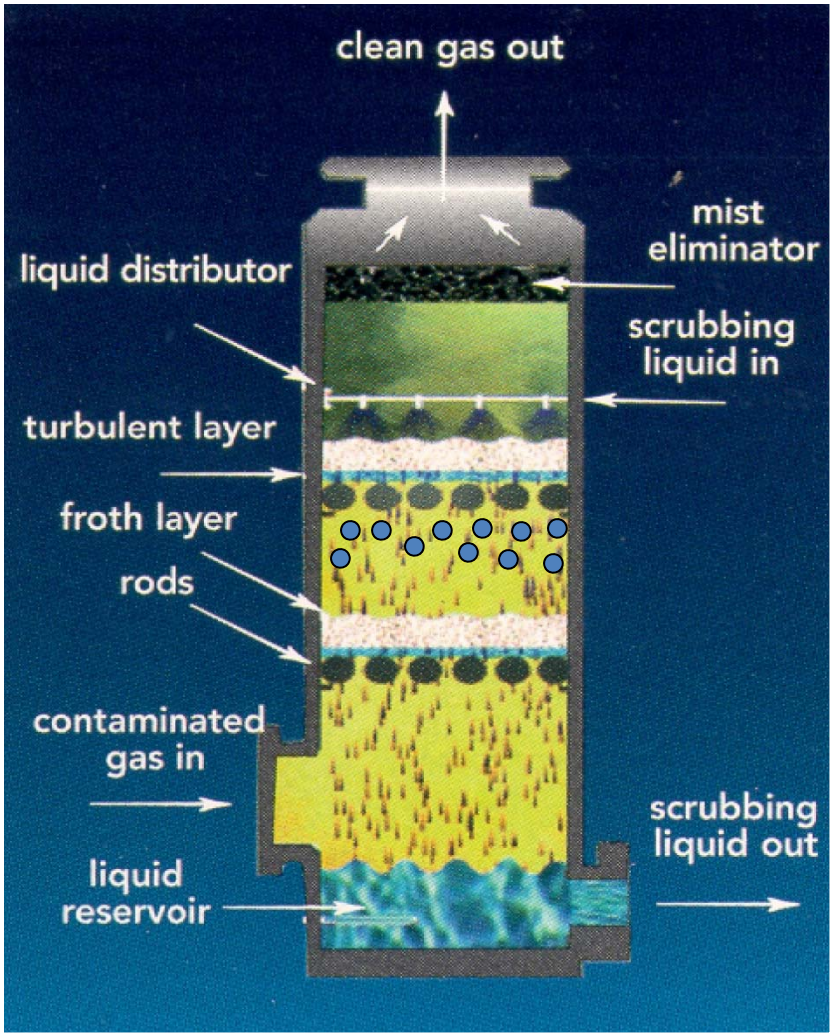
Major Insights

- Bromine improves Hg oxidation & activated carbon performance
- SO_3 impacts activated carbon Hg removal performance
- Hg removal & oxidation is a function of temperature
- Fabric filter dust cake make-up is vital to ACI ultimate performance
- Co-benefit and carbon approaches are the only viable candidates for commercial use



Hg Control Basics

- Three forms of mercury: elemental, oxidized & particulate
- Percentage depends on flue gas constituents'
- Oxidized Hg (soluble)
  - caught in WFGD with SO_2
- Elemental Hg (insoluble)
  - not captured in WFGD
  - other means of capture
- Particulate Hg (1% - 2%)
  - captured in ESP / FGD



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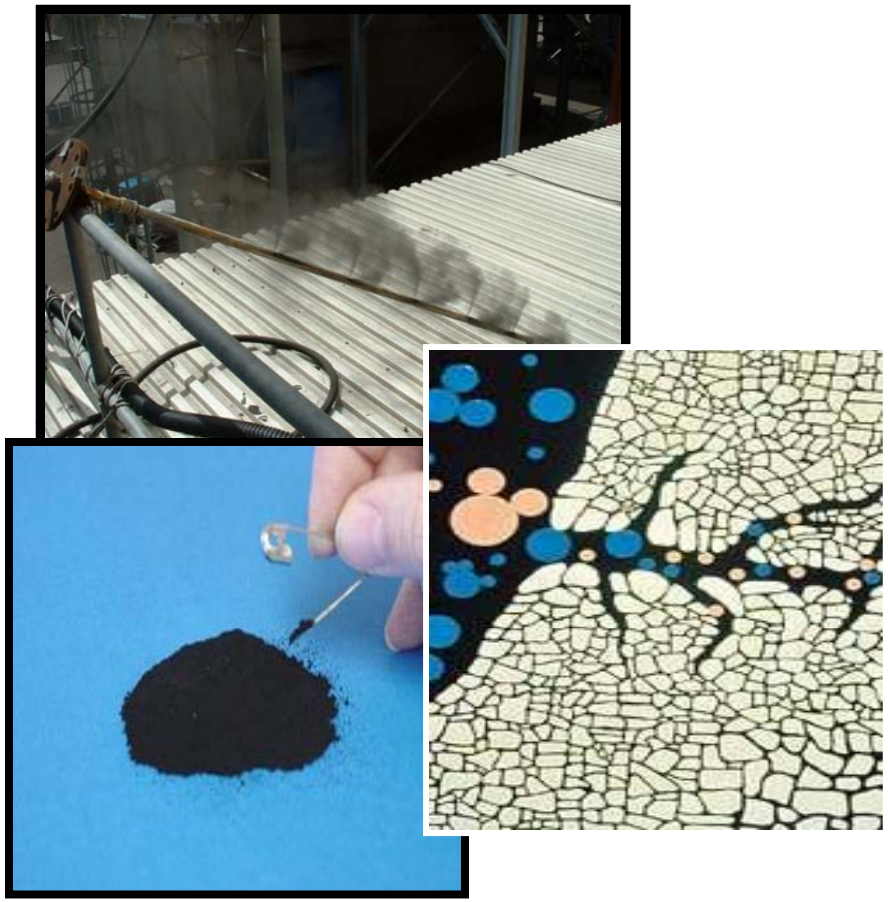
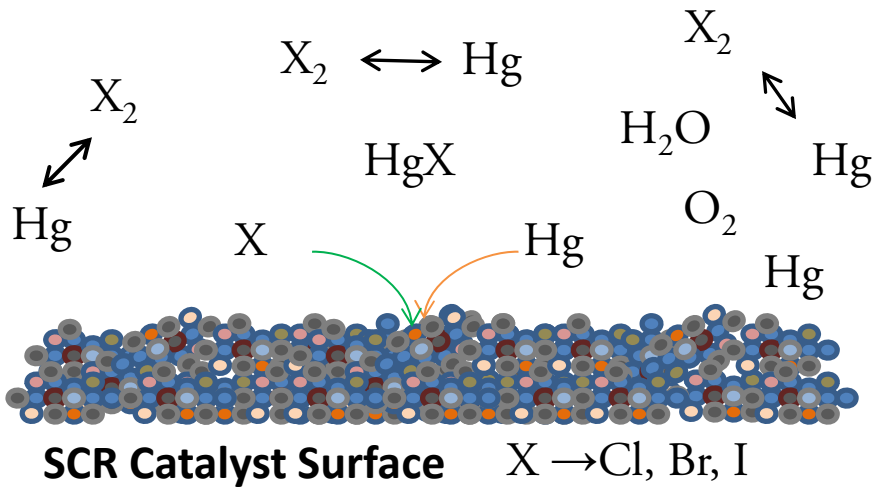
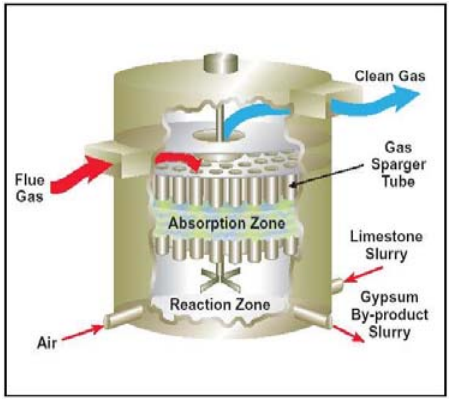
Mercury Specific Technologies



Adsorption Approaches (Solid)





Absorption Approaches (Liquid)

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Adsorption: Background

Typical properties:

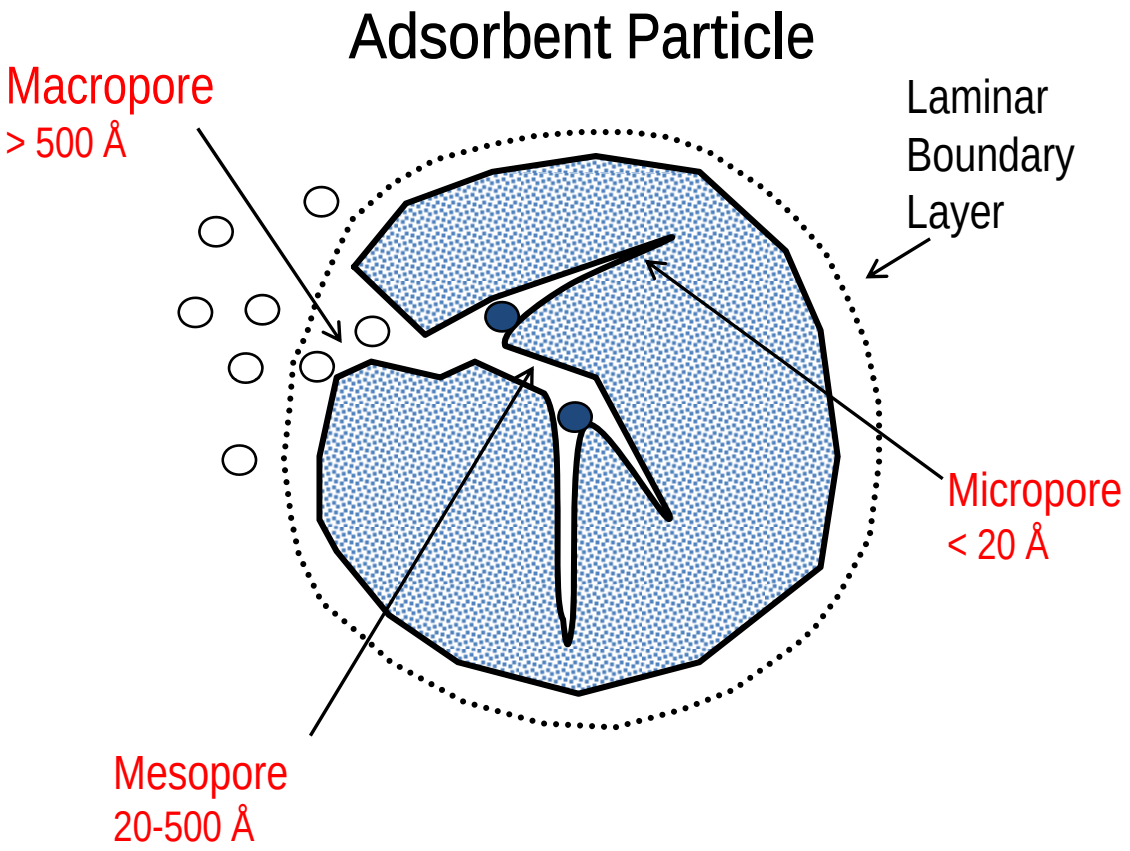
- 5 μm to 1.2 cm
- 300 to 1,200 m^2/g
- 30 to 85 vol%

Steps:

1. External diffusion
2. Internal Diffusion
3. Adsorption (physical or chemical)

Applications:

- water treatment
- Air pollution control



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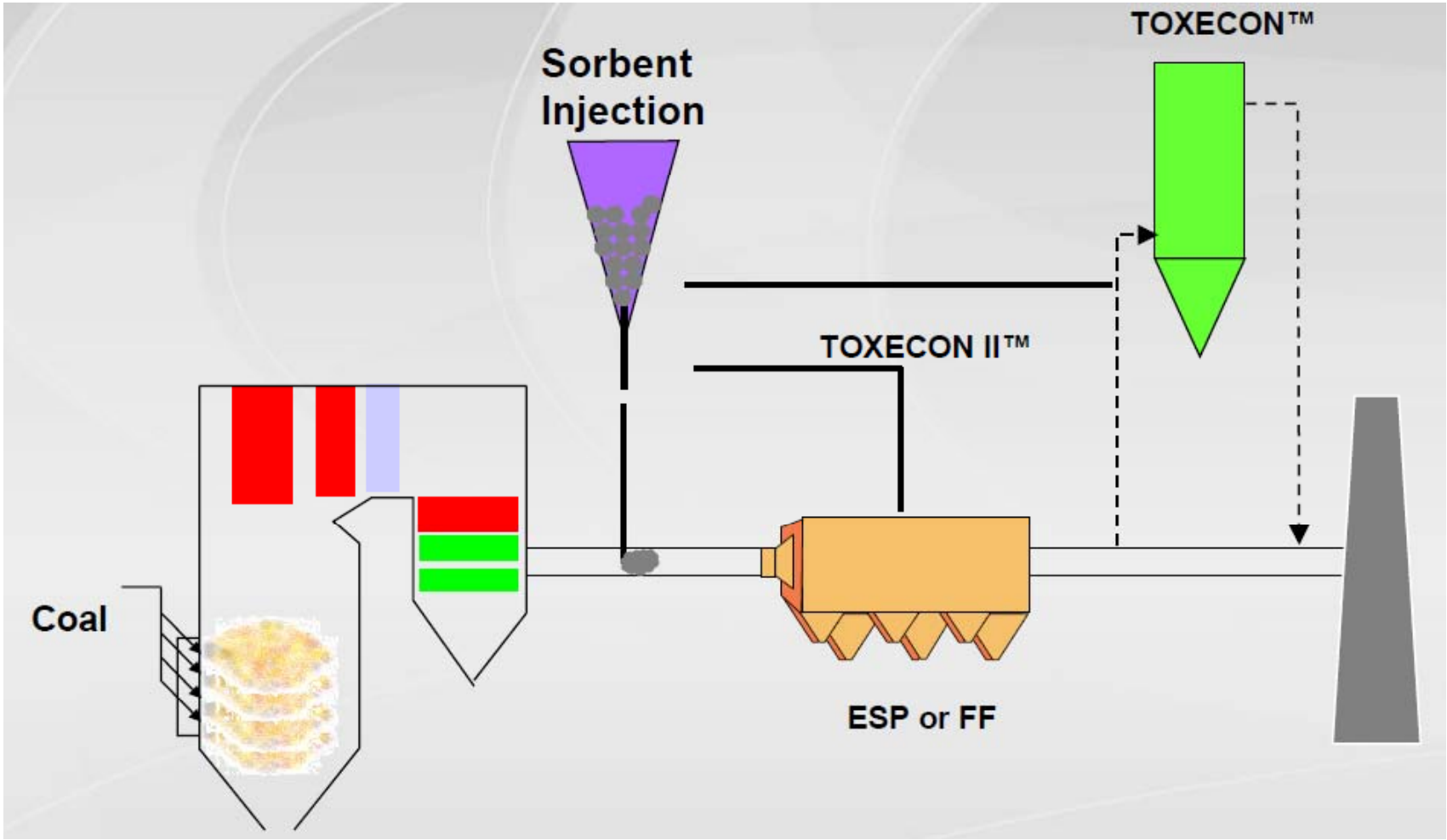
The Concept



Compliments of ADA.ES

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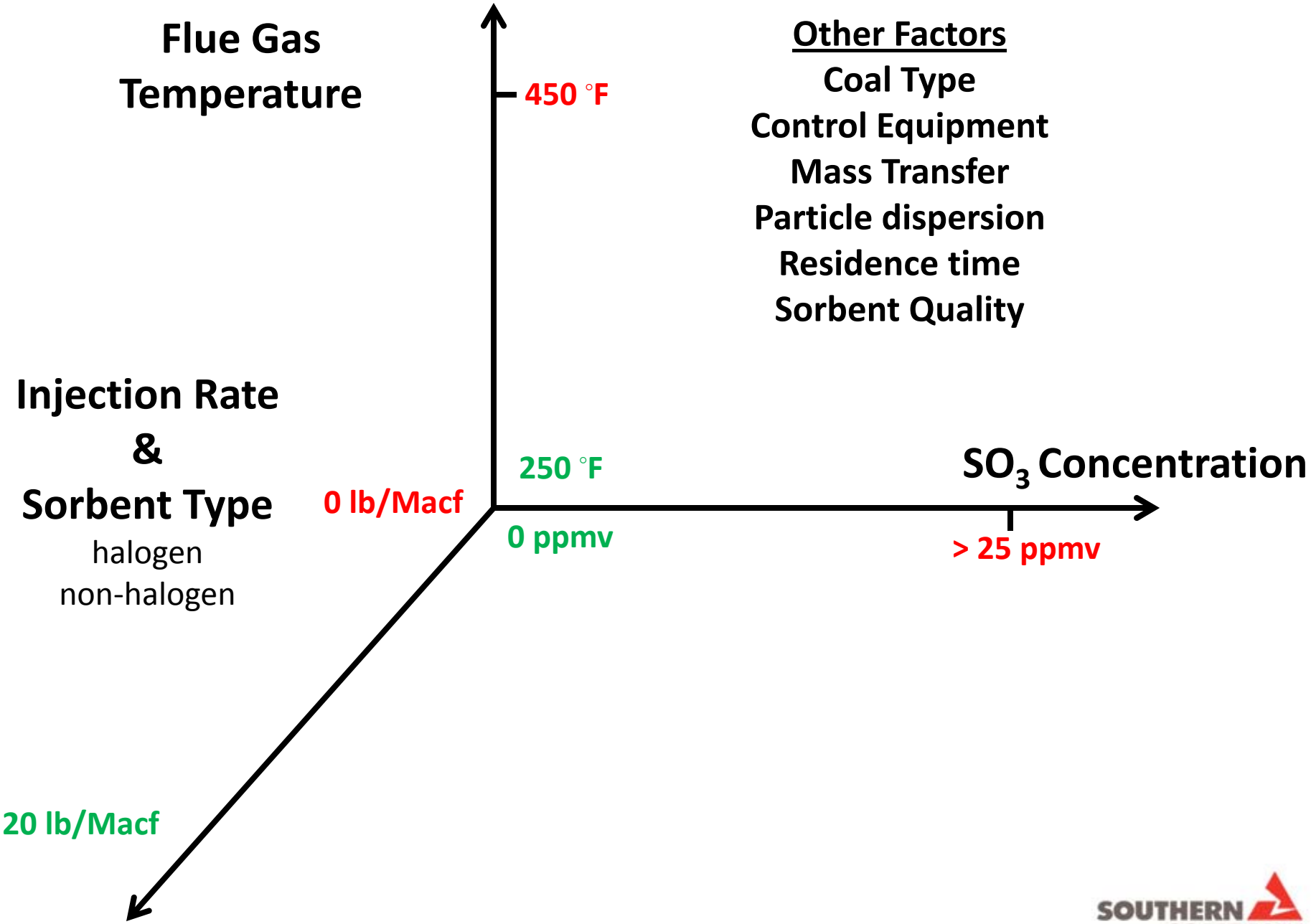
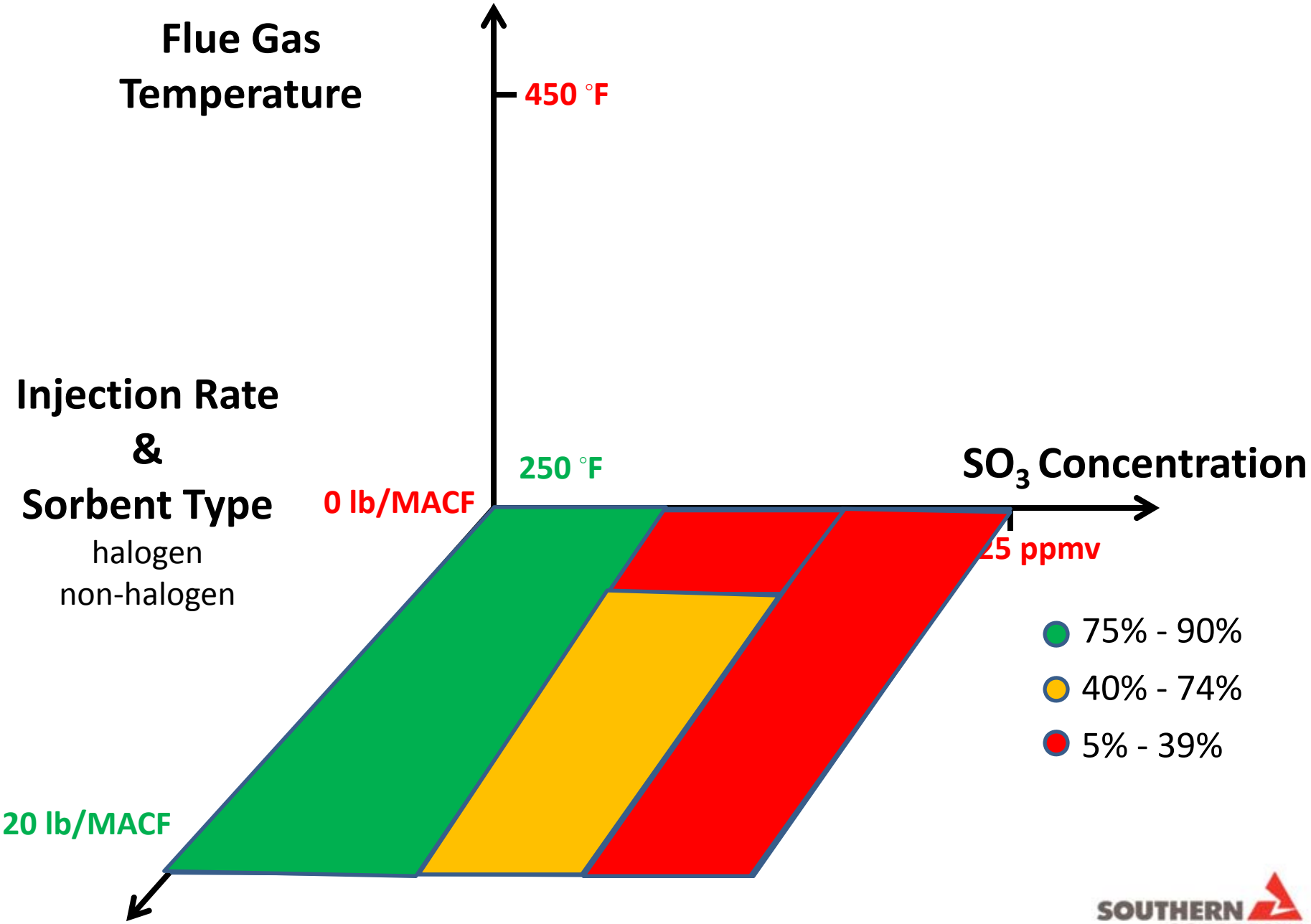
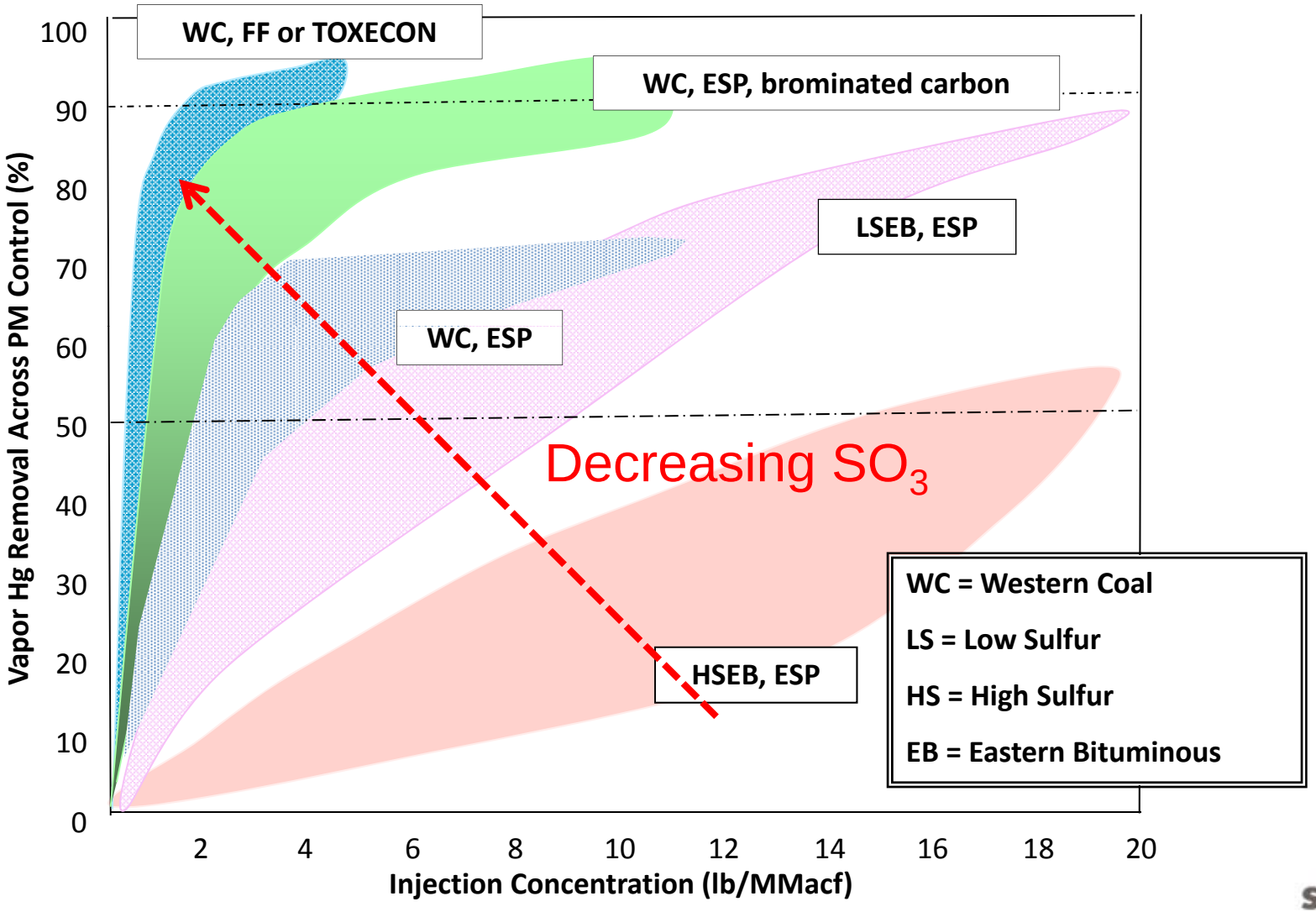

Flue Gas Temperature
450 °F
250 °F
0 lb/Macf
0 ppmv
Injection Rate & Sorbent Type
halogen
non-halogen
20 lb/Macf
SO3 Concentration
> 25 ppmv
Other Factors
Coal Type
Control Equipment
Mass Transfer
Particle dispersion
Residence time
Sorbent Quality


Flue Gas Temperature
450 °F
250 °F
Injection Rate & Sorbent Type
halogen
non-halogen
0 lb/MACF
20 lb/MACF
SO3 Concentration
25 ppmv
75% - 90%
40% - 74%
5% - 39%

Activated Carbon Removal Trends



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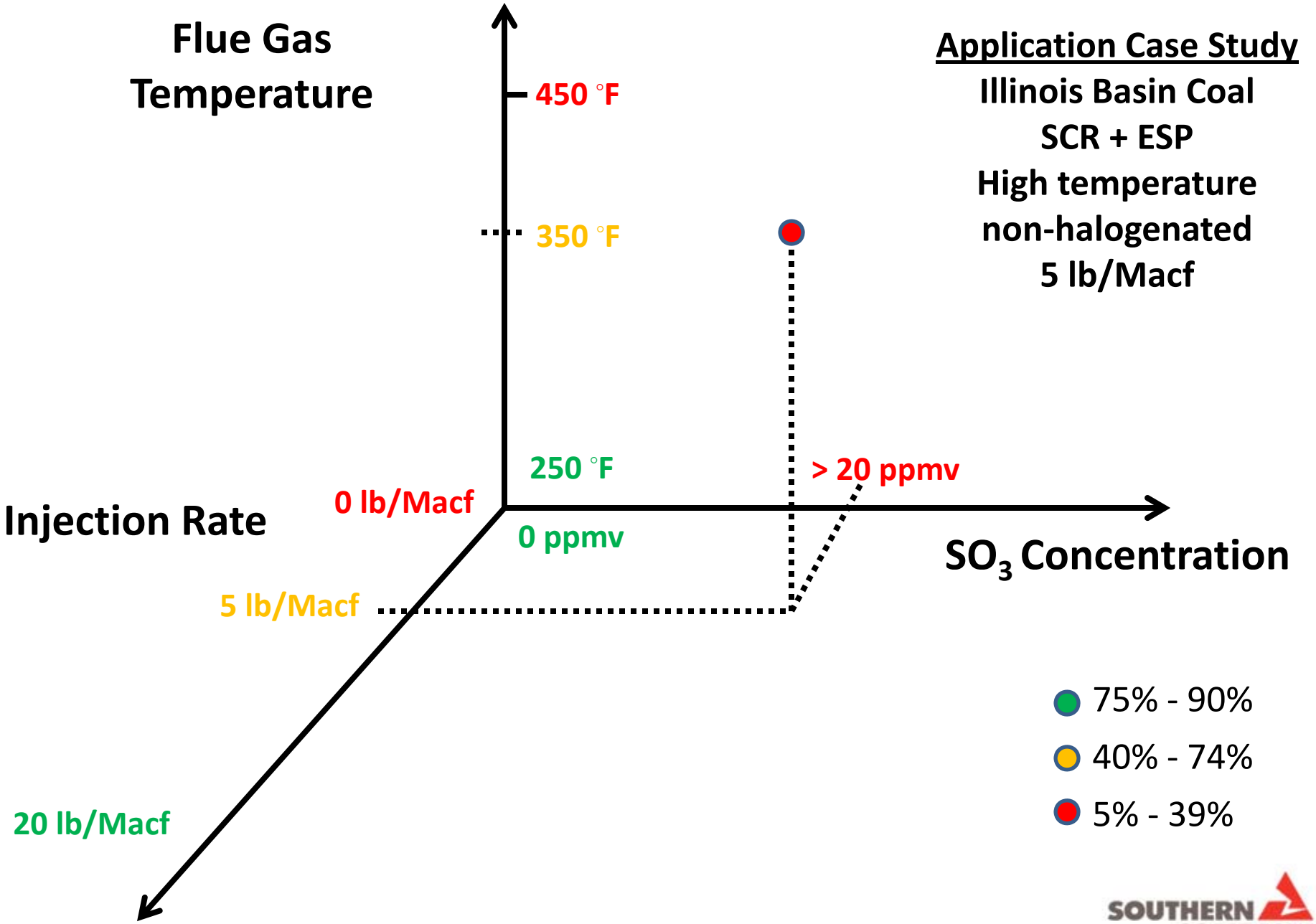
Flue Gas Temperature
450 °F
350 °F
250 °F
Application Case Study
Illinois Basin Coal
SCR + ESP
High temperature
non-halogenated
5 lb/Macf
> 20 ppmv
0 lb/Macf
Injection Rate
0 ppmv
SO3 Concentration
5 lb/Macf
20 lb/Macf
75% - 90%
40% - 74%
5% - 39%
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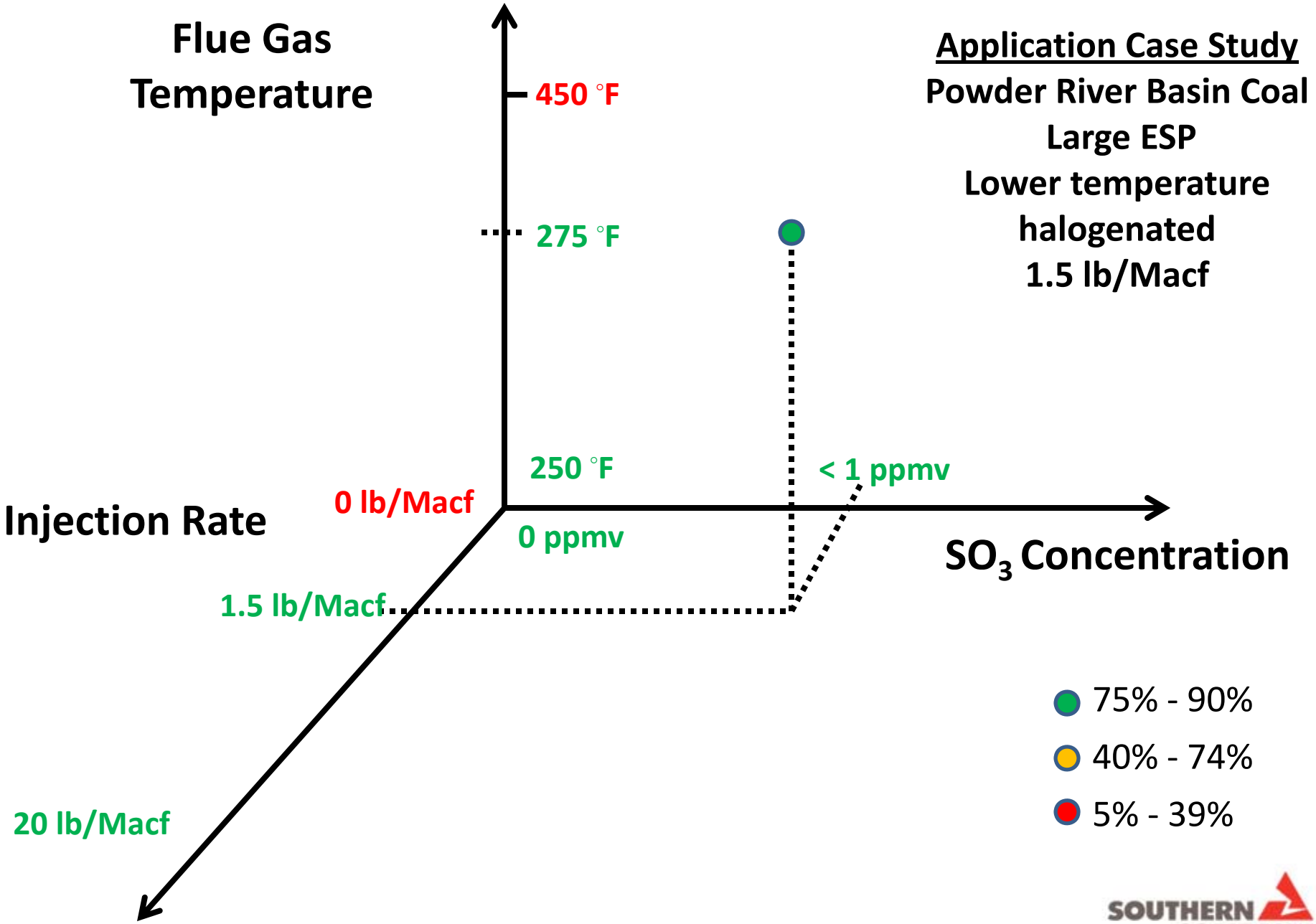
Flue Gas Temperature
450 °F
275 °F
250 °F
0 lb/Macf
Injection Rate
0 ppmv
< 1 ppmv
1.5 lb/Macf
SO3 Concentration
20 lb/Macf
Application Case Study
Powder River Basin Coal
Large ESP
Lower temperature halogenated
1.5 lb/Macf
75% - 90%
40% - 74%
5% - 39%

Performance Improvement Techniques

- Decrease SO_3 Interference
  - Use of Alkali sorbents
  - Change Fuels
  - Eliminate flue gas conditioning
- Decrease Temperature
  - Capital upgrades (Air heater modifications)
- Designer Carbons
  - Higher S tolerance
  - Chemically treated carbons
- Increase residence time + improve dispersion
- Increase mass transfer characteristics (i.e. baghouse)

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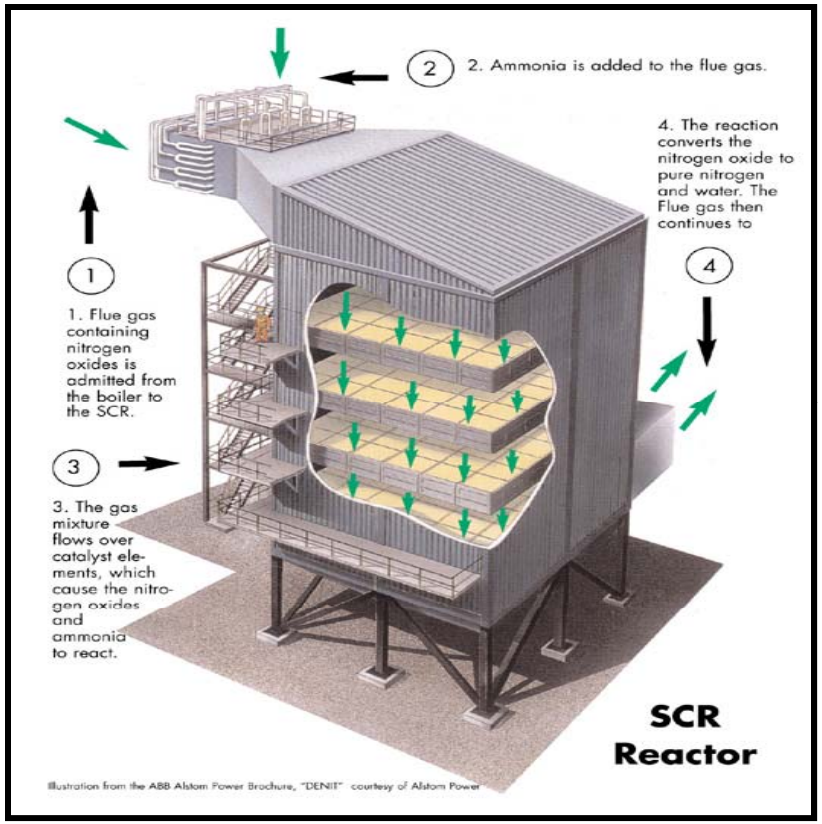
Hg Oxidation Technology

- Occurs as a byproduct of the NO_x to N_2 reduction process
- Competes with same sites a NH_3 + NO_x reaction sites
- Special Hg Oxidation SCR catalyst formulations available
- Halogen content of the coal
- Coal Cl promotes oxidation
- Halogen can be added to promote oxidation



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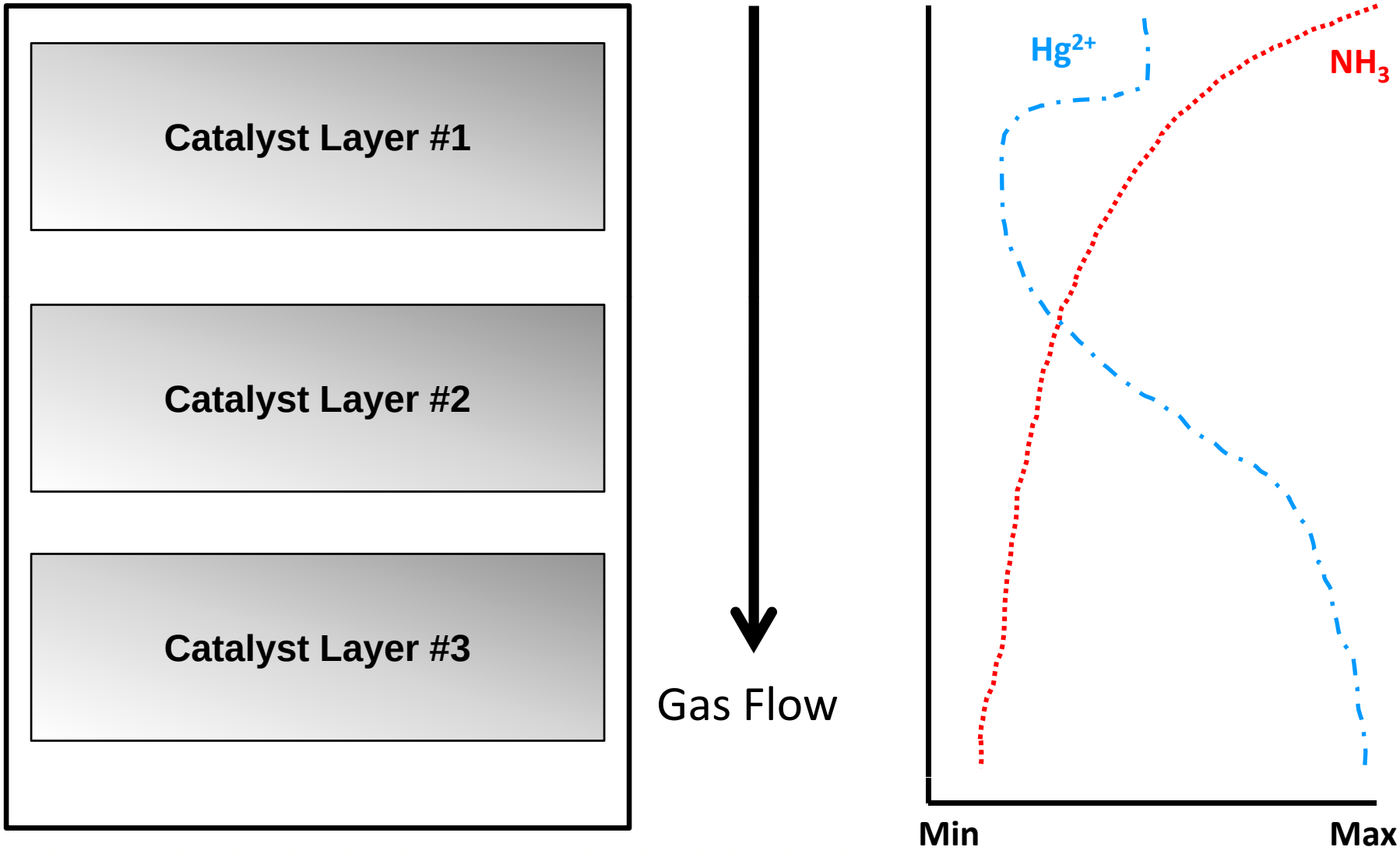
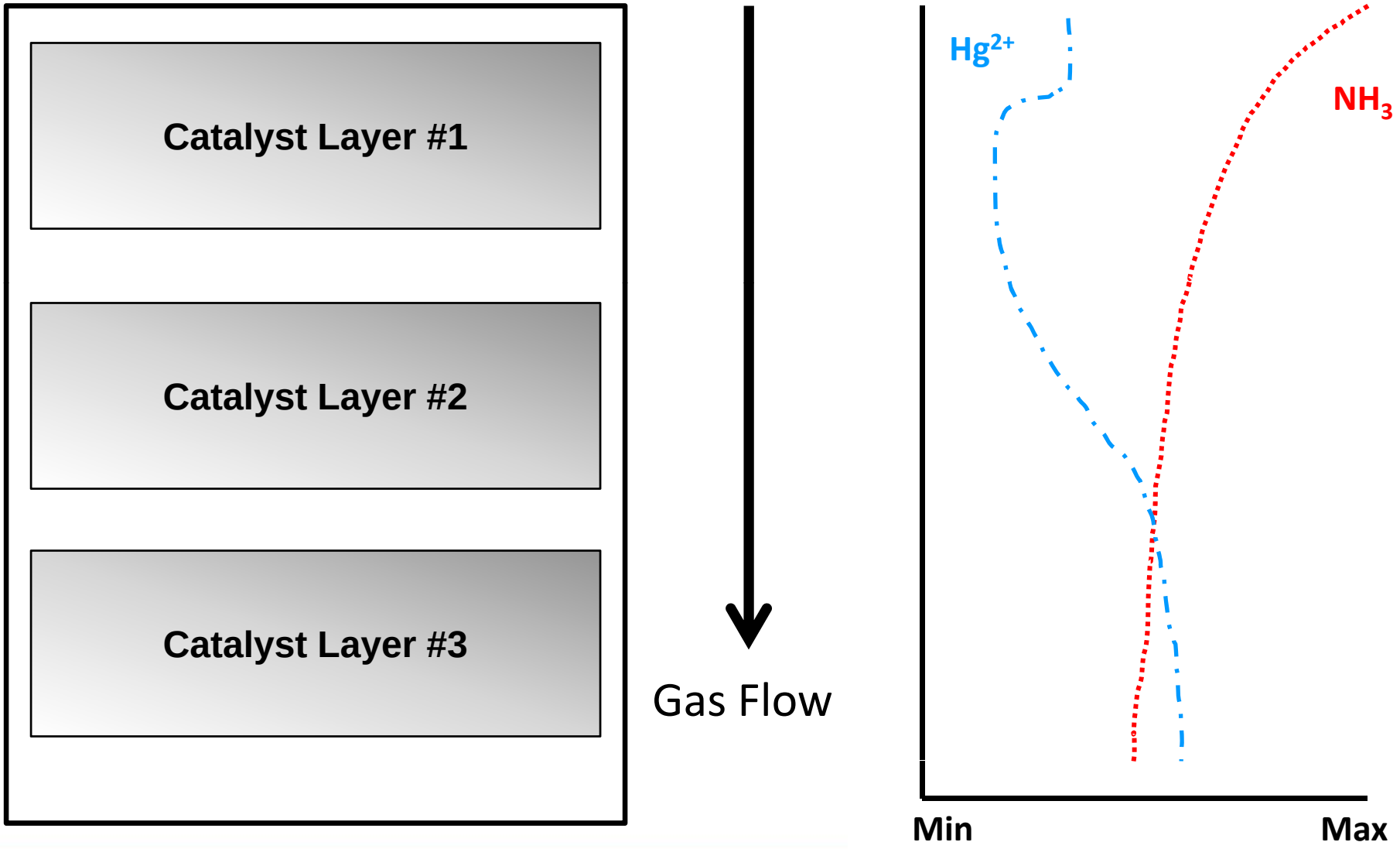
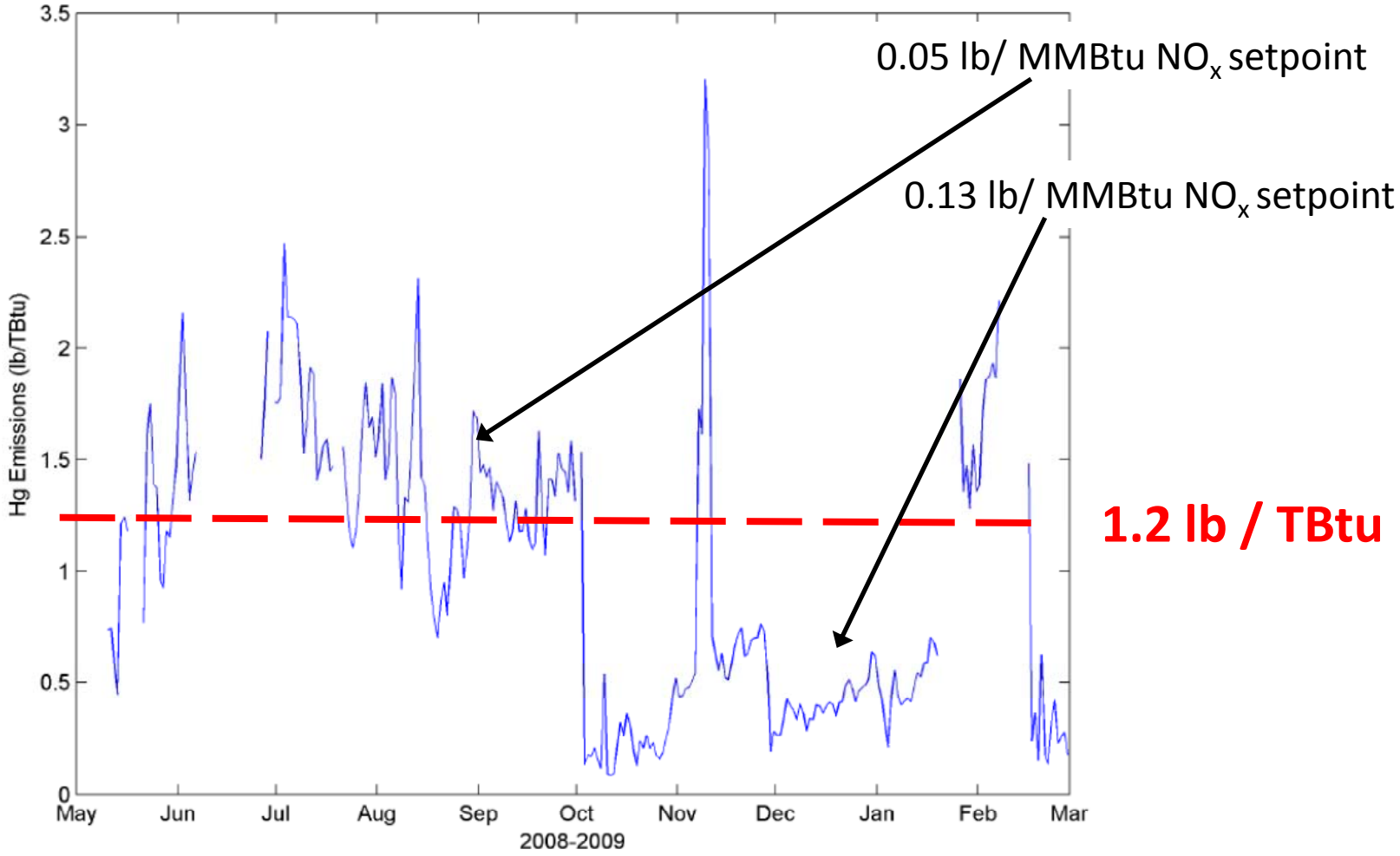
Hg Behavior Correlates w/ SCR Operations



Hg Behavior Correlates w/ SCR Operations



Hg Emissions Correlates w/ SCR Operations



900 MW Eastern bit unit with SCR and wet FGD

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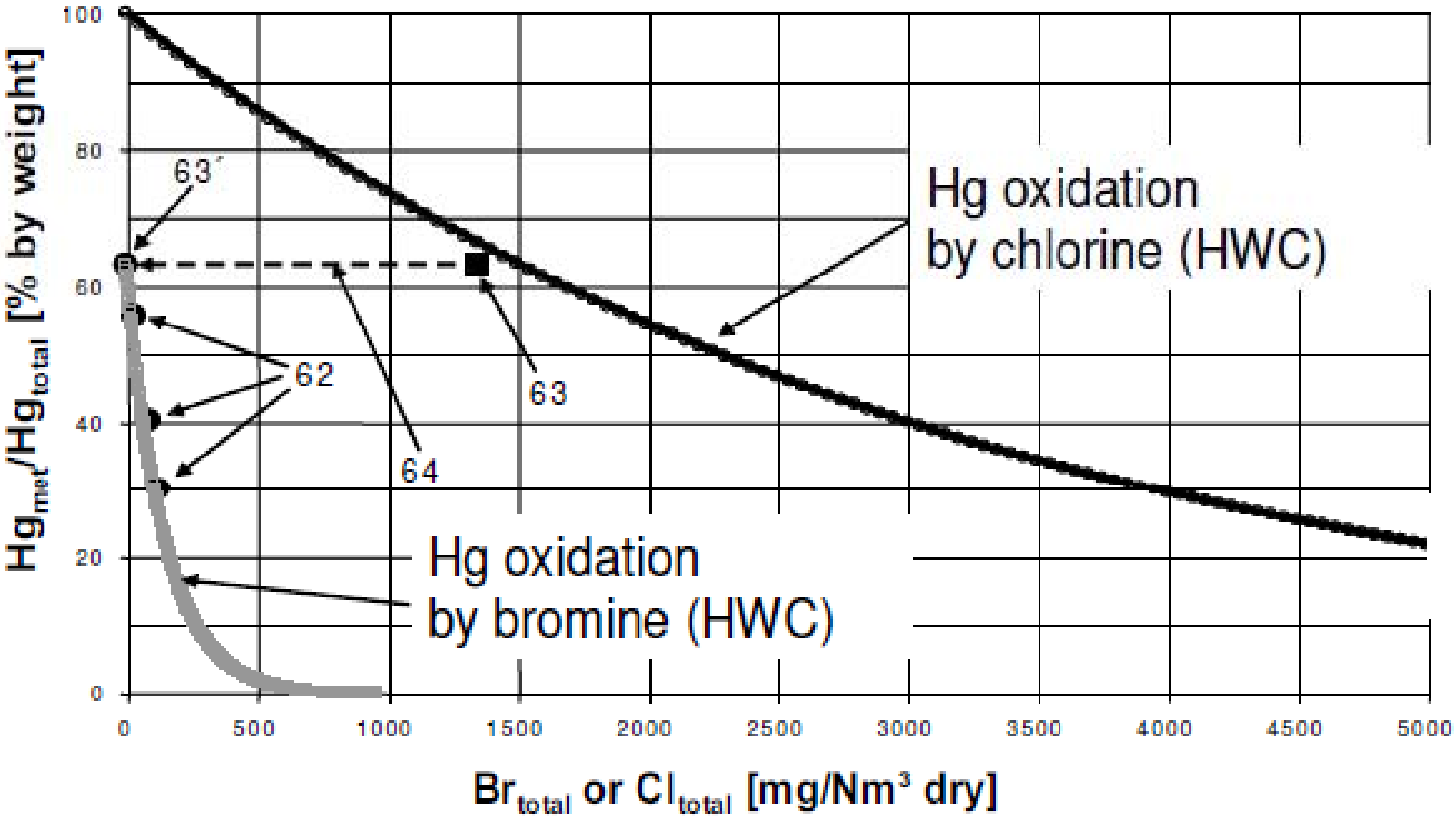
Bromine vs. Chlorine



Provided by Bernhard Vosteen

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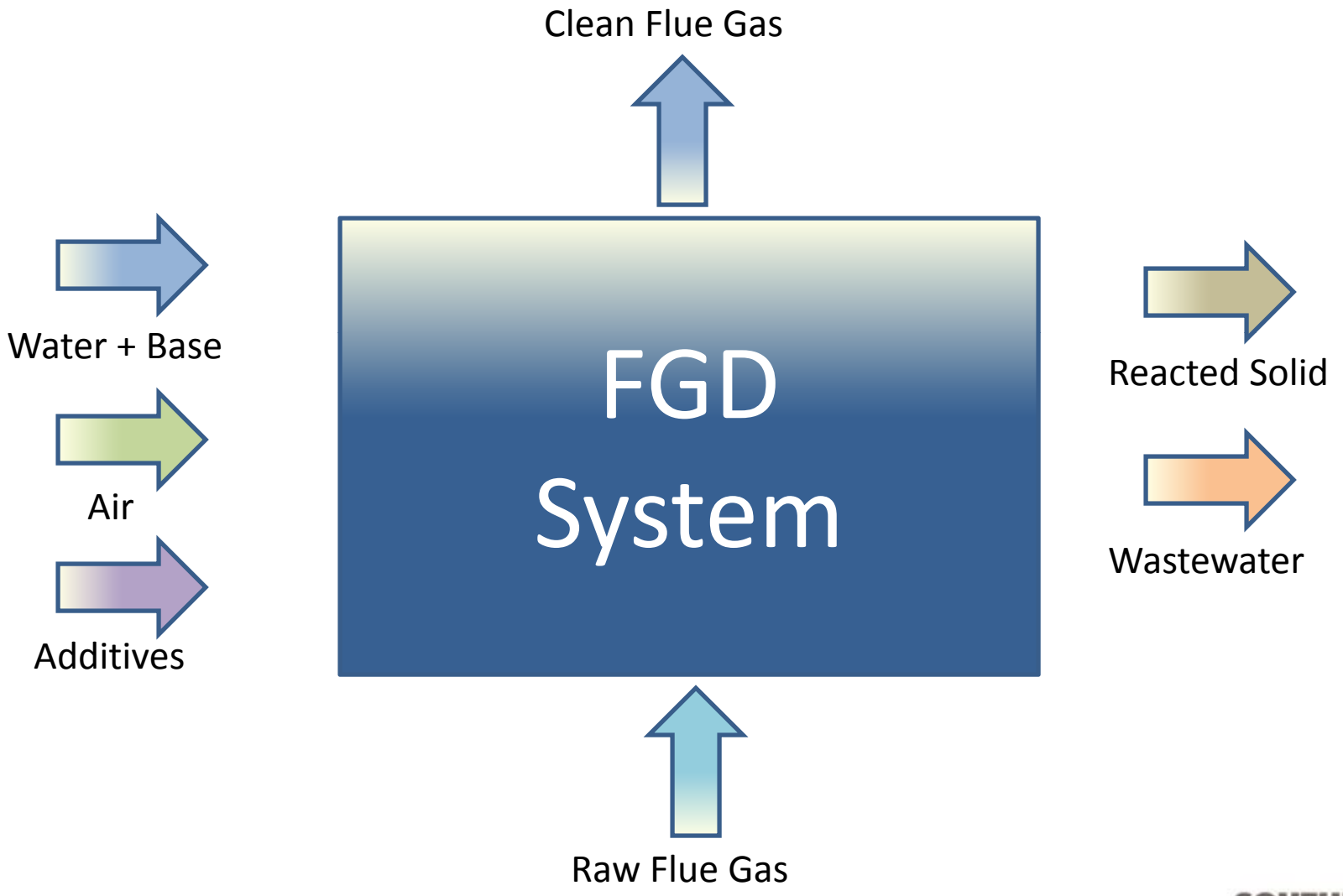
SO_2 Scrubbers



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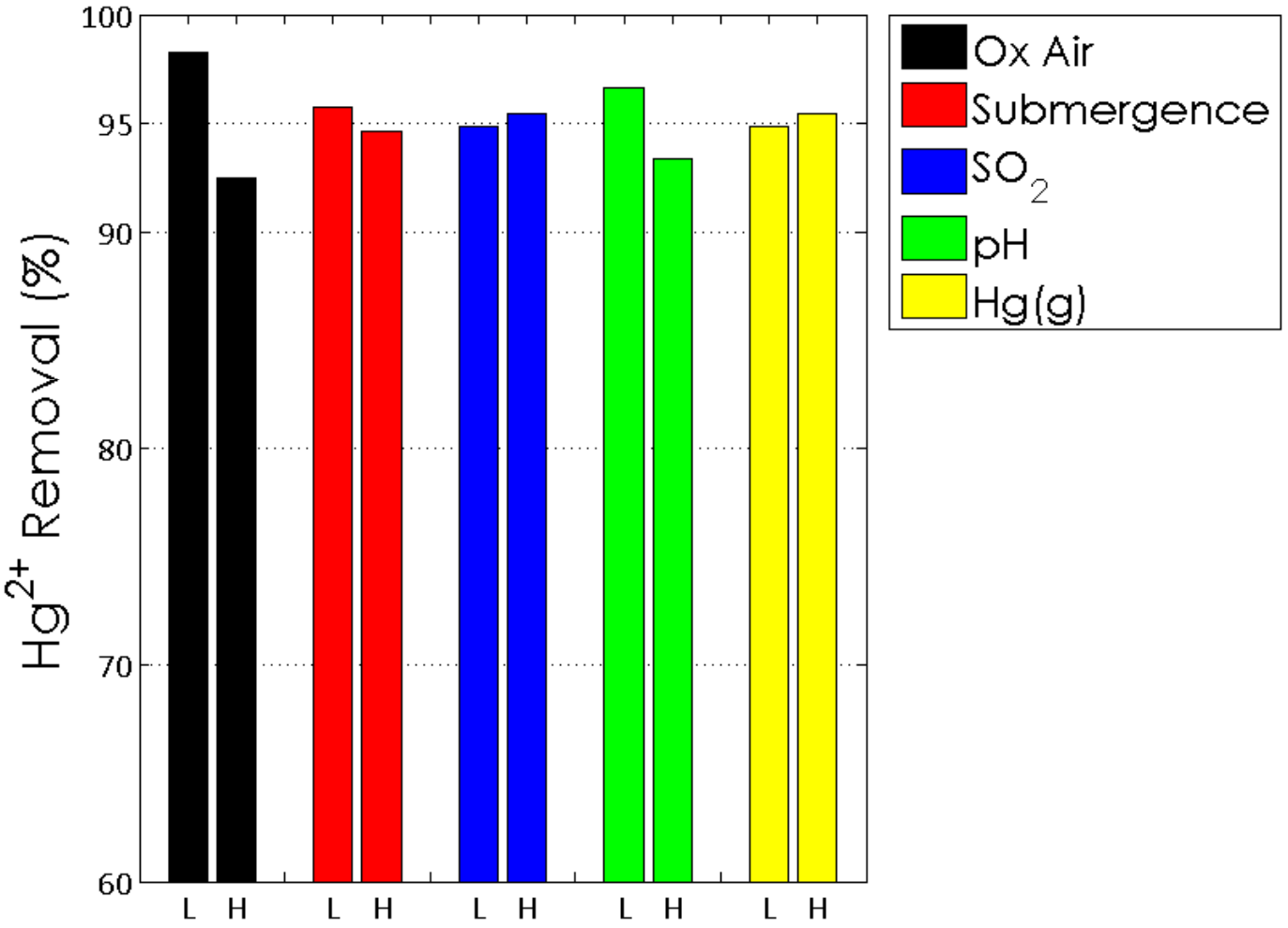
Variables that affect Hg^{2+} capture



Oxidized mercury capture averaged 95% and was independent of fuel S, fuel Hg, liquid submergence, pH, and oxidation air.

Performance Improvement Techniques

Increase Hg Oxidation

- Purchase Hg Oxidation Catalyst
- Replace catalyst more frequently
- Increase halogen content artificially
- Decrease NH_3 concentration
- Decrease flue gas temperature

Manage wet FGD operations

- Minimize Hg re-emissions
  - Use of chemical additives

Mercury Research Center
Pilot wet FGD

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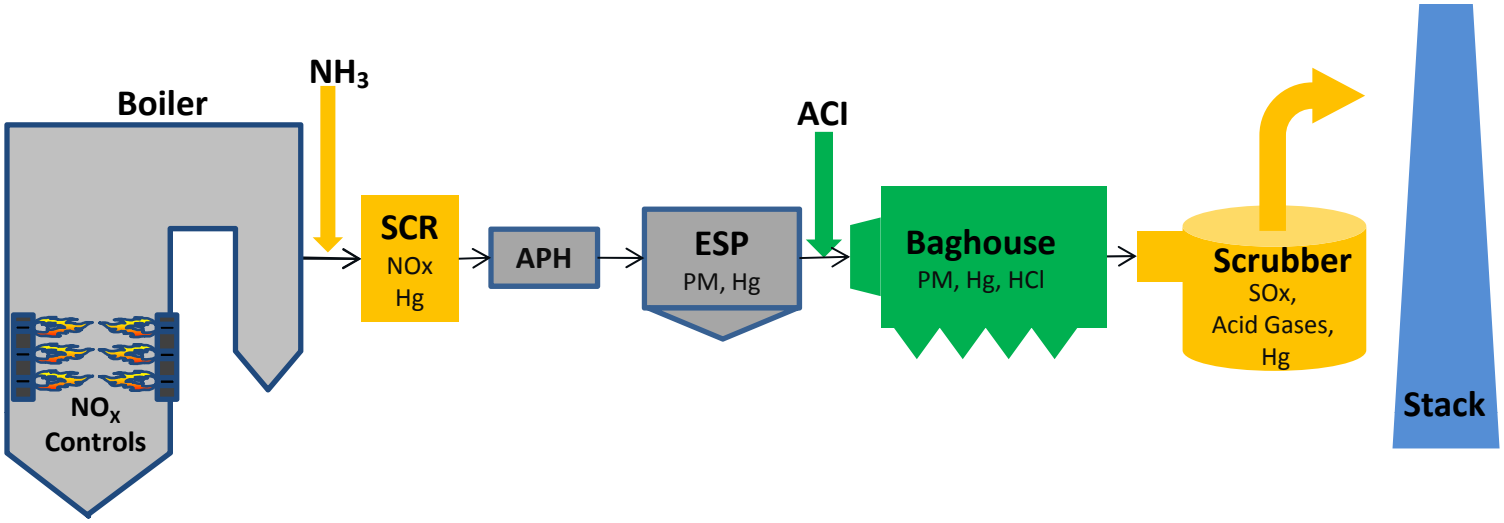
Example – "What Happens to Mercury"



	Boiler	Boiler Exit	SCR	ESP	TOXECON	FGD	Removal
Hg^0	10						
Hg^{2+}	0						
Hg^T	10						
Removal							

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