EUEC 2014

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HClear™ : A Solution-Based Approach to HCl Abatement

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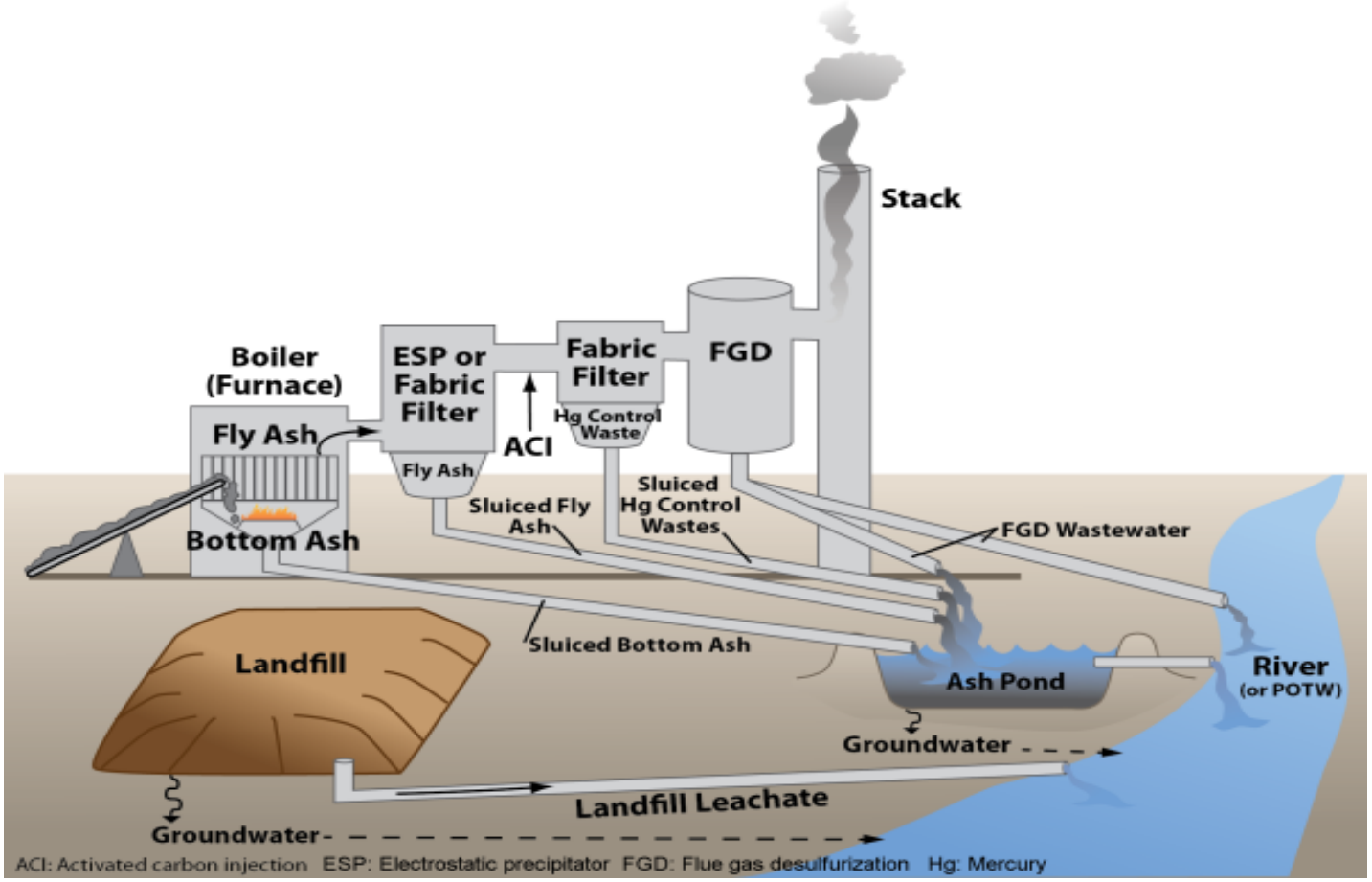
Outline

- Regulatory Drivers
- HCl Reduction ahead of wet FGD
- What is HClear™?
- Our Approach
- Performance
- Conclusions

HCl Regulatory Drivers

- MATS
  - 0.002 lbs/MMBtu limit
- ICI-MACT
  - 0.022 lbs/MMBtu
- 40 CFR Part 423 - Effluent Limitation Guidelines
  - Proposed in June 2013
  - Guidelines to regulate effluent water quality
  - Pollutants of Concern from wFGD
    - Total suspended and dissolved solids, As, Se, B, etc.

Liquid Waste Streams in EGUs



adapted from : water.EPA.gov/scitech/wastetech/guide/steam-electric/proposedimage.cfm

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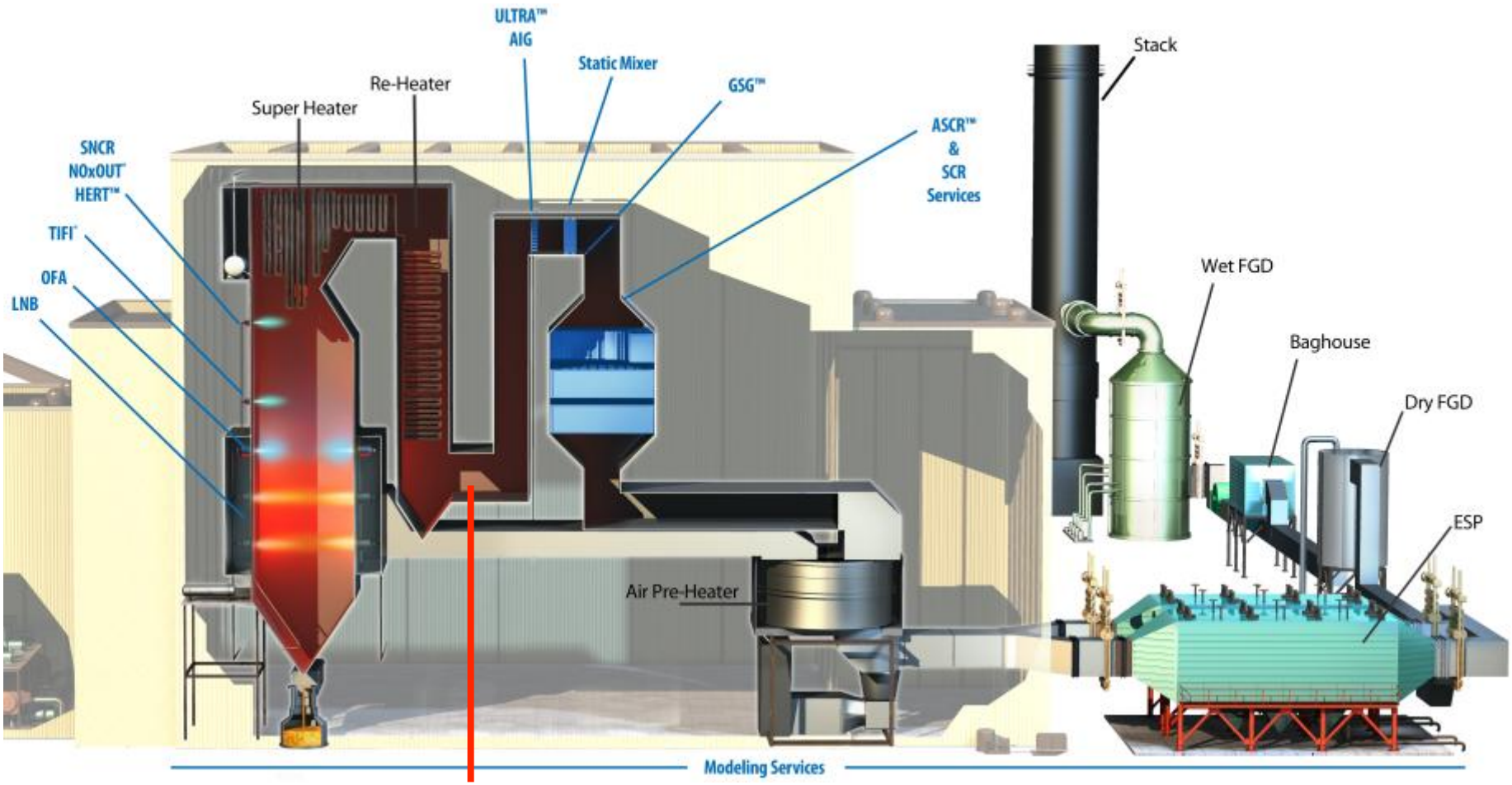
Effluent Limitation Guidelines (ELG) Compliance

- Wastewater treatment
  - Remove total suspended solids (TSS), precipitation of heavy metals
    - Hg, Pb, Fe, Ca, Mg, Cu
- Some pollutants cannot be removed in wastewater treatment plant (WWTP)
  - As, Se, B, Cl
- Zero liquid discharge
  - Evaporate/crystallize and landfill sludge

What is HClear™?

- A liquid that selectively reacts with HCl
  - Aqueous solution
  - No reaction with SO_2 or SO_3
- Highly efficient reaction (low dosages)
  - 1 – 10 lbs solution/ton of fuel
- Simple to apply
- Forms an insoluble chloride-containing product
  - No impact on leachability of toxic metals
- Minimal impact on particulate control devices
- Tested in pilot- and full-scale units
  - Small pilot, large pilot, industrial boiler, and utility boiler

HClear™ Application



Equipment for Utility Demonstration

Pump Skids

HClear™ Chemical Totes

Injectors

Mixing Manifold

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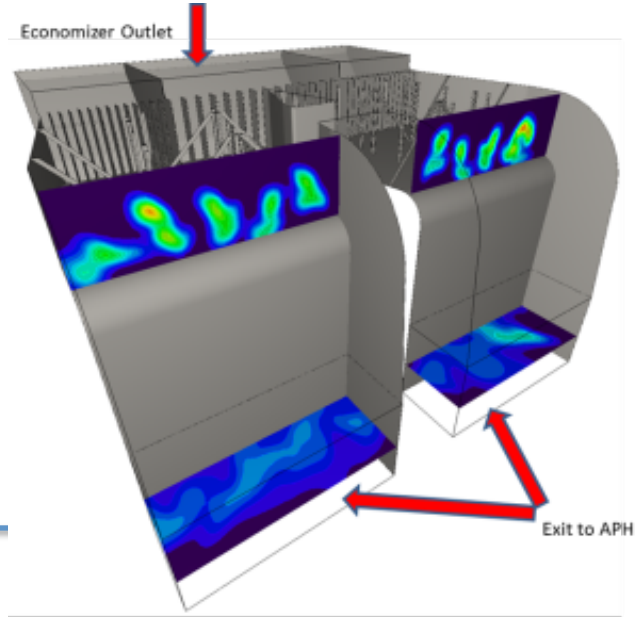
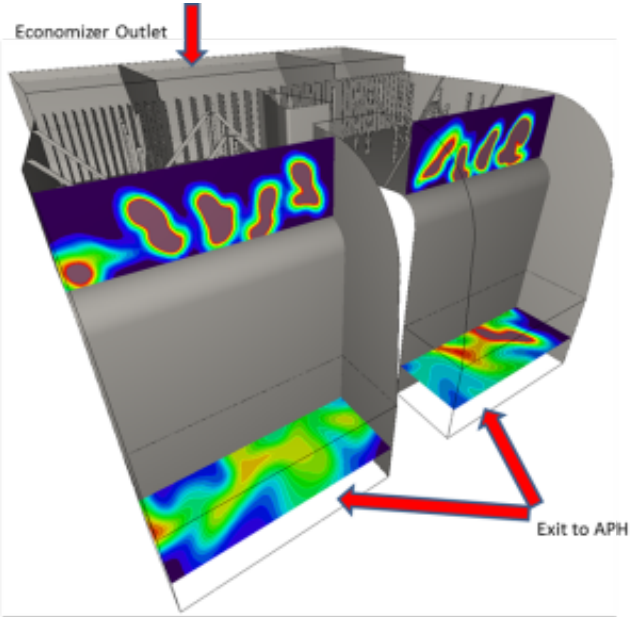
Duct Injection Technology

Extremely Fine Droplets

CFD and Chemical Kinetics Modeling





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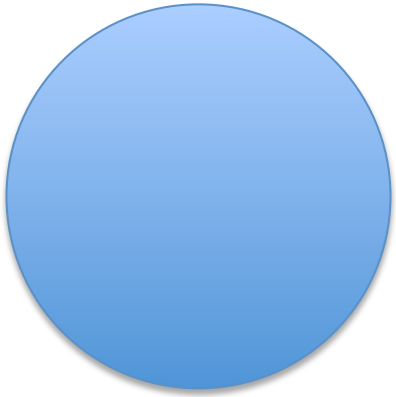
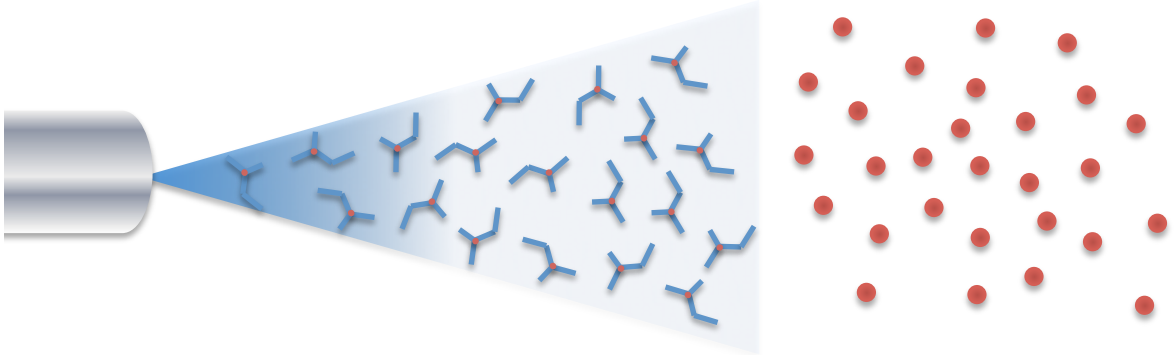
Molecular Precursor (Bottom-Up) Approach

Dry Sorbent Injection



hydrated lime: $d_{v0.5}$ ~ 5-10 μm
milled sodium sorbents $d_{v0.5}$ ~ 10-40 μm

HClear™ Program



molecular precursor

reactive particles
$d_{v0.5}$ << 1 μm

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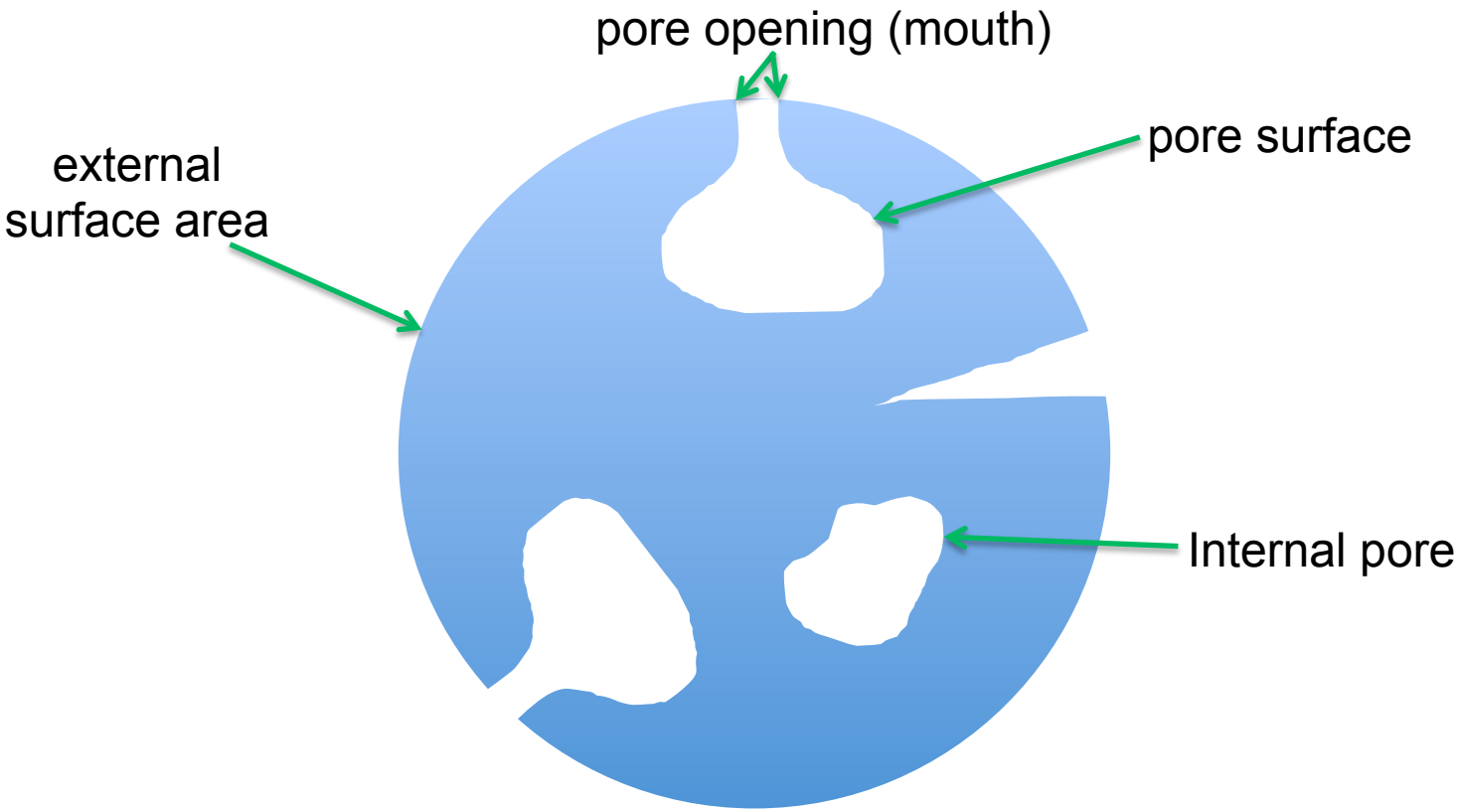
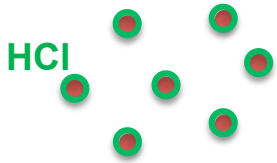
Types of Surface Area



Solid-Gas Reactivity

Ø = 5 μm
external SSA ~ 0.5 m^2/g



Ø = 0.3 μm
external SSA ~ 9 m^2/g

Rate of reaction

I. Gas film diffusion of HCl to particle
II. Pseudo-homogenous reaction (kinetics)
III. Reaction at pore openings (diffusion)
IV. Reaction inside pores (diffusion)
V. Reaction in internal pores (diffusion)

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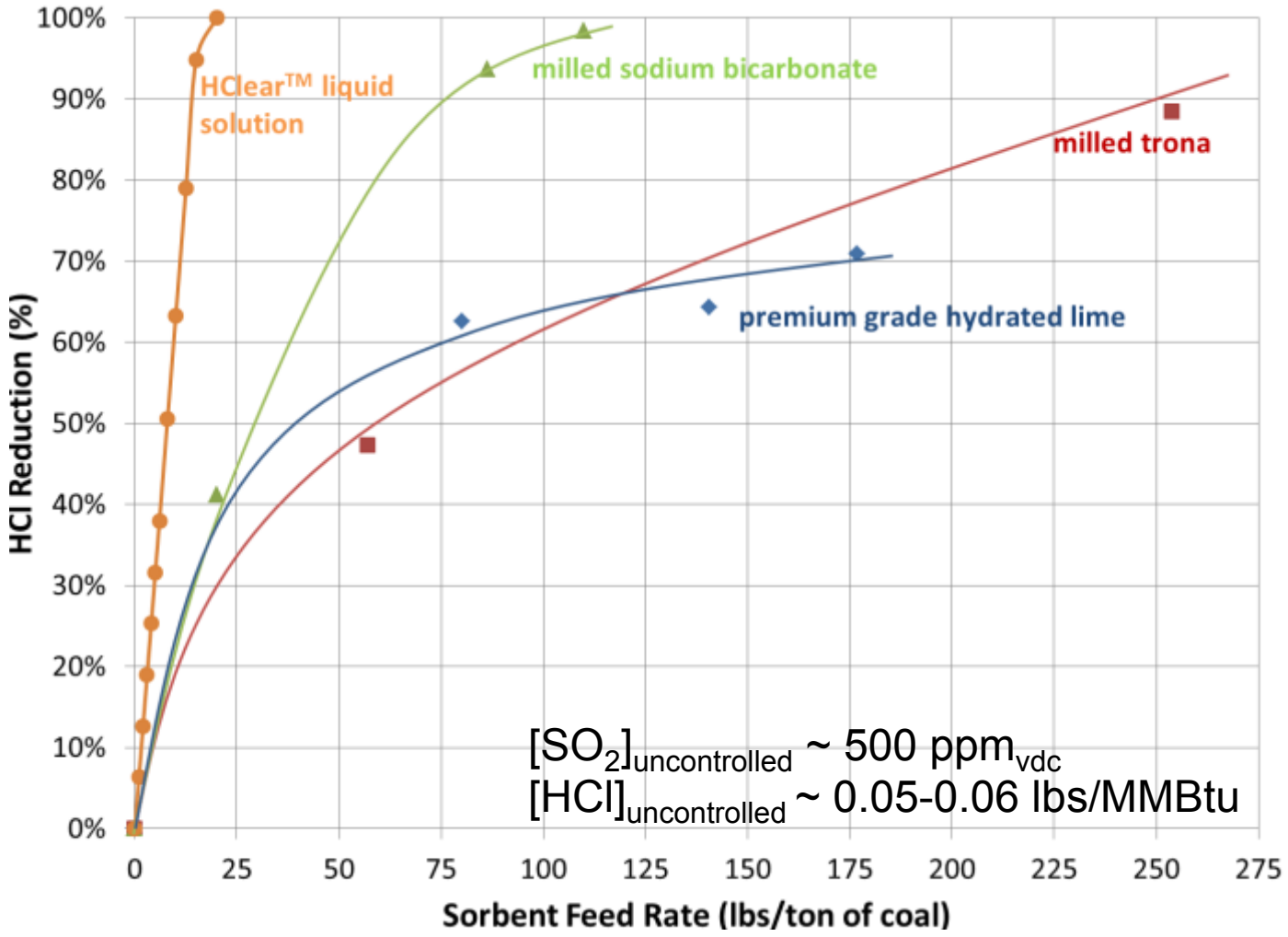
Performance



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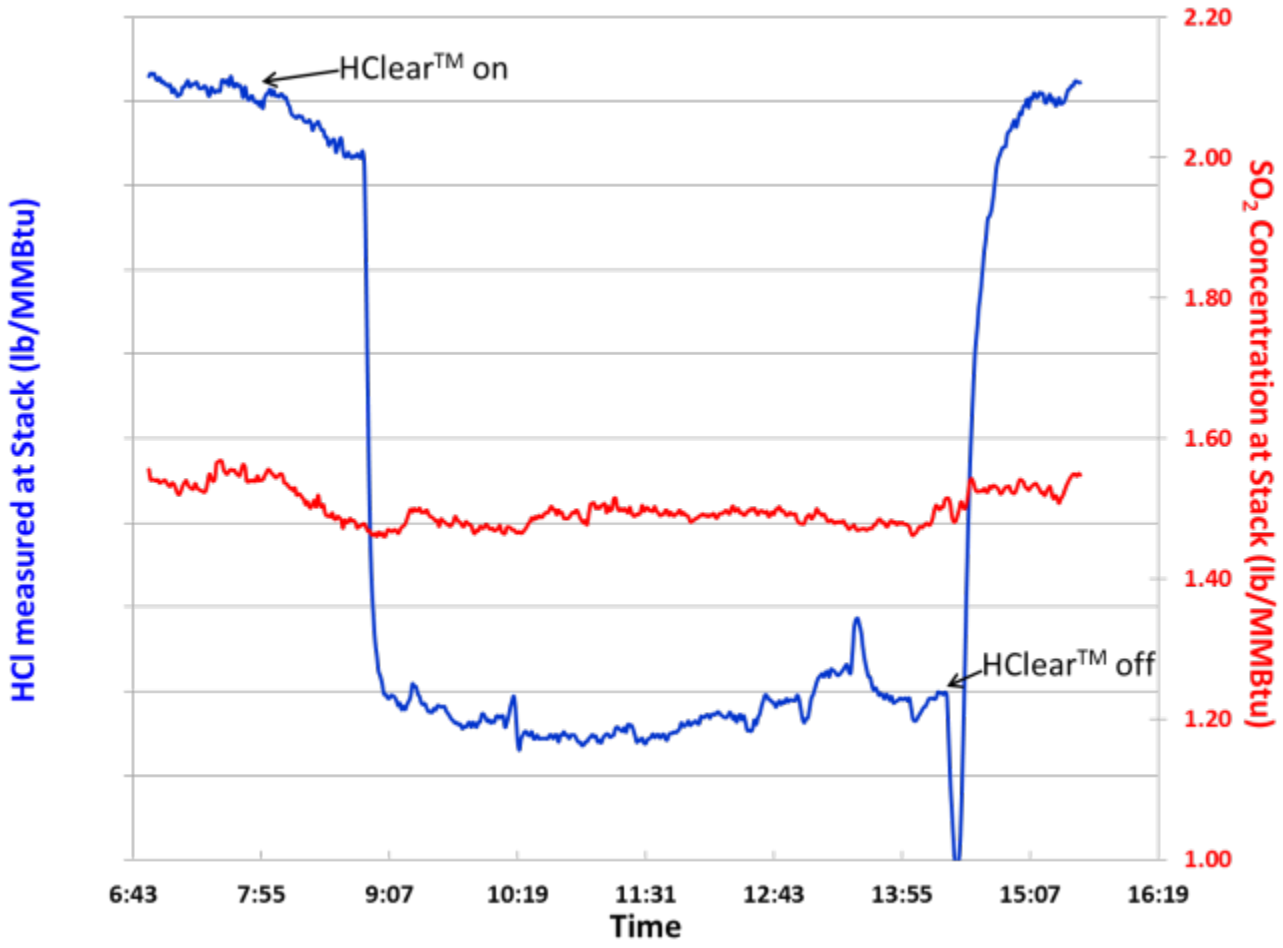
Selectively Towards HCl



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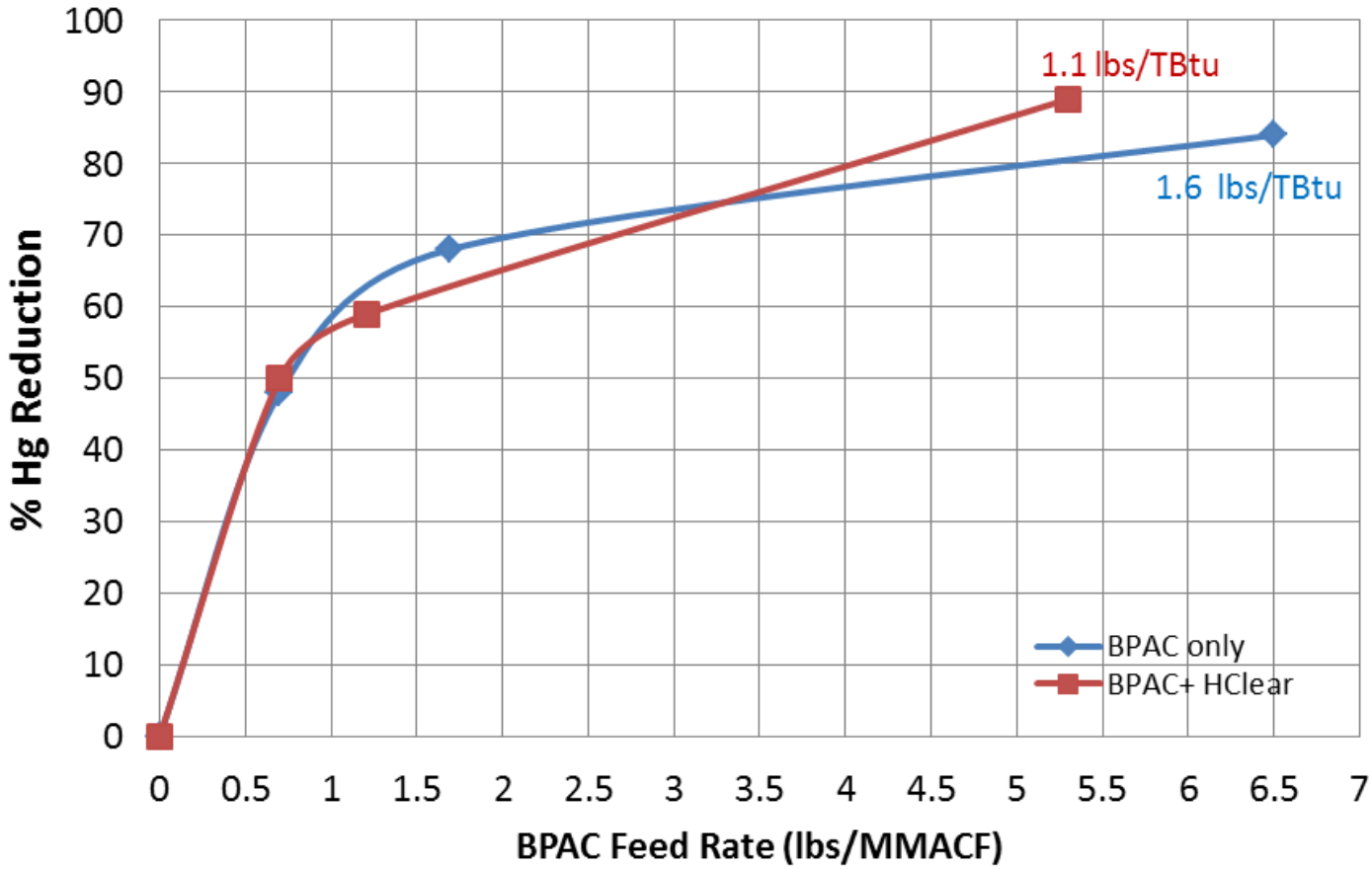
Impact on Hg Reduction with B-PAC



- No impact on Hg reduction by brominated PAC

Fate of Chlorides: Gas Phase Reduction

Flue Gas HCl Measurements			
	Baseline	Test	% Reduction
[HCl] (ppm_{vdc}, 3% O_2)	44.2	6.67	85 %
[HCl] (lbs/MMBtu)	0.043	0.007	83 %
Particulate loading (gr/dscf)	0.0043	0.0038	--

Fate of Chlorides : Ash Composition

Fly Ash Composition			
%	Baseline	Test	Difference
Cl^-	0.744	0.910	0.166
HClear™ active	0.113	0.280	0.167
Br^-	0.039	0.039	0

- Chlorides removed from flue gas by ESP

Fly Ash Leachability

TCLP Leachate			
HClear Dose (lbs/ton)	HCl Reduction (%)	Chloride (mg/L)	Leachate pH (s.u.)
x	44 %	227	7.2
2*x*	77 %	236	7.2

- Reaction product is insoluble (low leaching potential)
- No measurable impact on Ag, As, Ba, Cd, Cr, Hg, Pb, Se leachability

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Impact on wFGD Effluent

- Selective reduction of gaseous HCl entering wFGD
- Commensurate reduction in wFGD blowdown rates
  - Reduction of gaseous HCl results in decreased blowdown rates
- Reduced throughput to wastewater treatment plant (WWTP) and/or zero liquid discharge (ZLD) system
  - Smaller WWTP or ZLD
  - Lower capital costs
  - Decreased operating and maintenance (O&M) costs

Conclusions

- Simple, highly efficient HCl abatement program
- Selective for HCl
  - No reaction with SO_2/SO_3
- Small equipment footprint
- Minimal increase in solids mass loading
  - No impact on ESP
- HCl captured as insoluble product
- Decrease chloride concentration into wFGD
  - Decrease chloride bleed/blowdown rates
  - Reduce the volume of water to treat by WWTP and ZLD

Thank You

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