

BASF's Mercury Sorbent HX™

A Mercury MATS Compliant Technology

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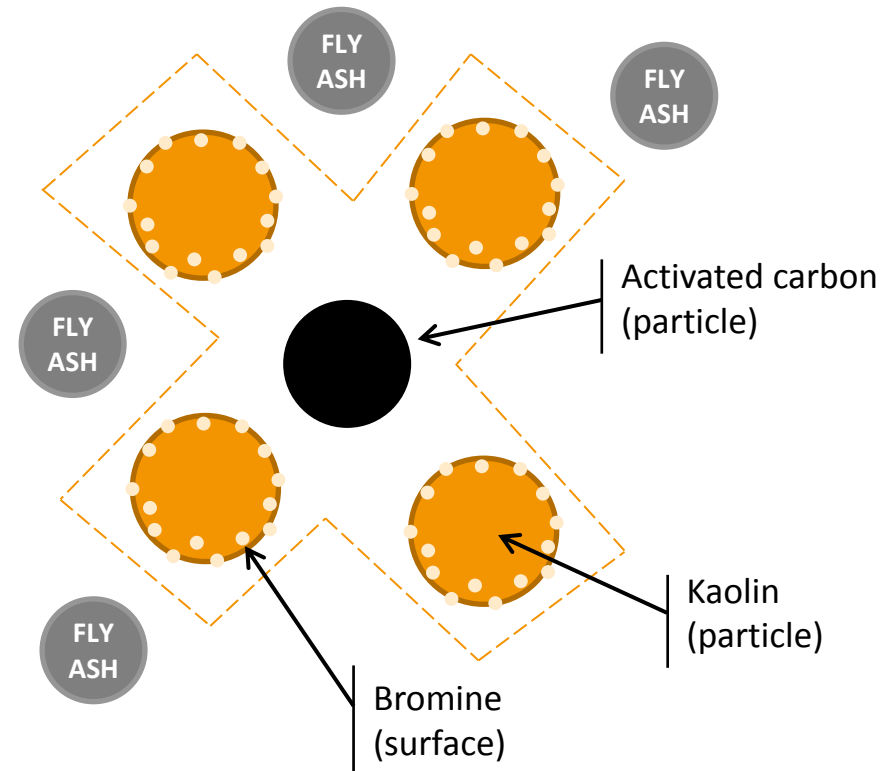
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Overview

- Mercury Sorbent HX™
- MATS compliant mercury emissions demonstrated
 - Review of field trials
 - An established pattern of compliant performance
- Preserved fly ash properties in concrete
- A “low carbon in the fly ash” solution for mercury emissions compliance
- Summary

Mercury Sorbent HX™ is a brominated mineral sorbent enabling a low carbon solution for mercury emissions compliance

- Macroporous mineral selected to optimize bromine utilization in system
- Untreated PAC offers uninhibited access to mercury capture sites
- Bromine content provides sufficient mercury oxidation with minimal potential impact on balance of plant

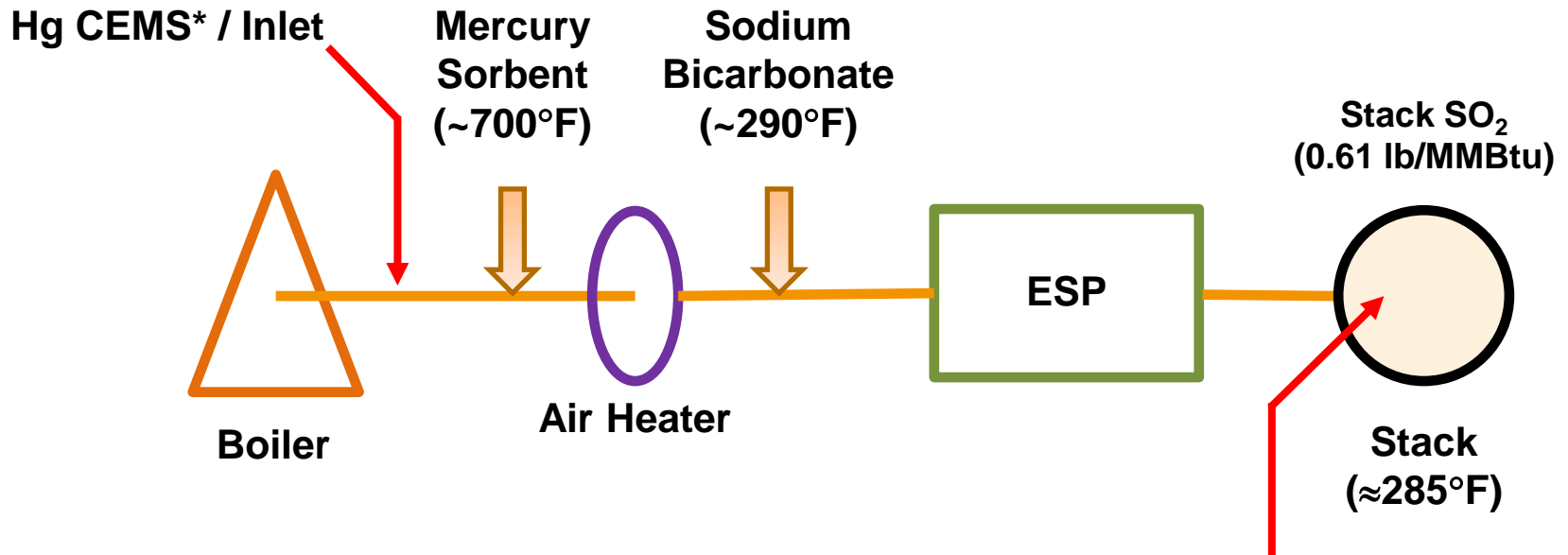


Mercury Sorbent HX™

Field demonstration programs

Site	A	B	C
Coal	Powder River Basin	Powder River Basin	Powder River Basin
Nominal load capacity	800 MW	200 MW	300 MW
Particulate collection device	ESP	ESP	Fabric filter
Coincident Dry Sorbent Injection (DSI)	No	Yes	No
DSI material	n/a	Sodium bicarbonate	n/a
Mercury sorbent injection location	Upstream air preheater	Upstream air preheater	Upstream air preheater
DSI injection location	n/a	Downstream air preheater	n/a
Injection system design	Eductor	Rotary valve	Rotary valve
Fly ash currently sold	Yes	Yes	Yes

Mercury Sorbent HX™ Equipment schematic – Site B



PRB Coal Assay

S	0.34% – 0.36%
Cl	5ppm – 6ppm
Hg	85ppb – 168ppb

Thermo Scientific Mercury CEMS*
[* CEMS = Continuous Emissions Monitoring System]

Mercury Sorbent HX™

Test matrix – Site B

Test program	1	2
Sodium bicarbonate injection	On	Off
Injection methodology	Parametric	n/a
Mercury sorbent injection	On	On
Injection methodology	As needed for MATS Hg compliance	Parametric

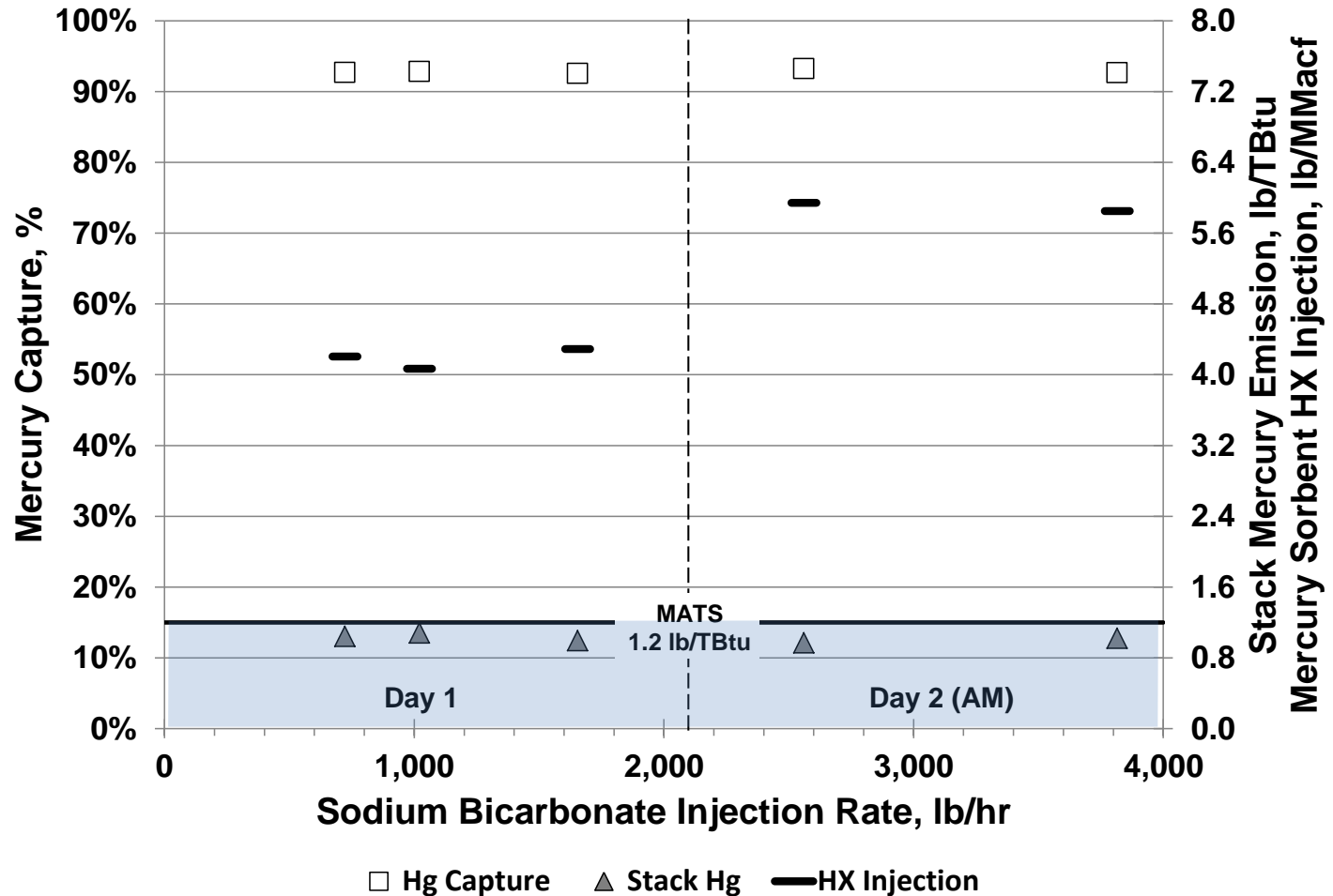


Portable injection systems used for dry sorbent and mercury sorbent injection

Test Program 1 – Parametric SBC injection with MATS mercury compliant emissions

- Steady intraday mercury sorbent injection rates for MATS compliance
- Analysis inconclusive as to cause(s) of step change in mercury sorbent injection rate between successive days

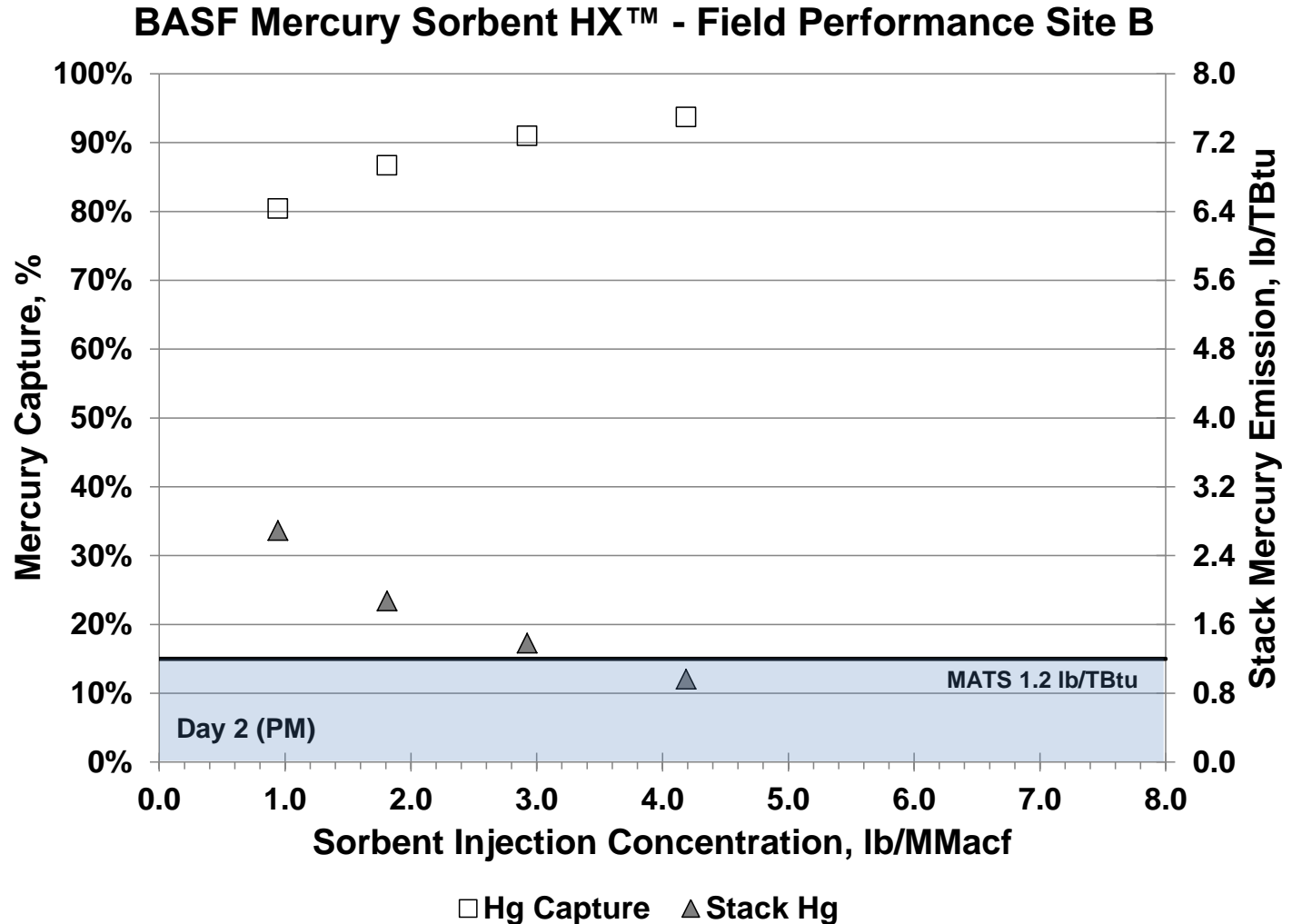
Dual Injection - Field Performance Site B



Test Program 2

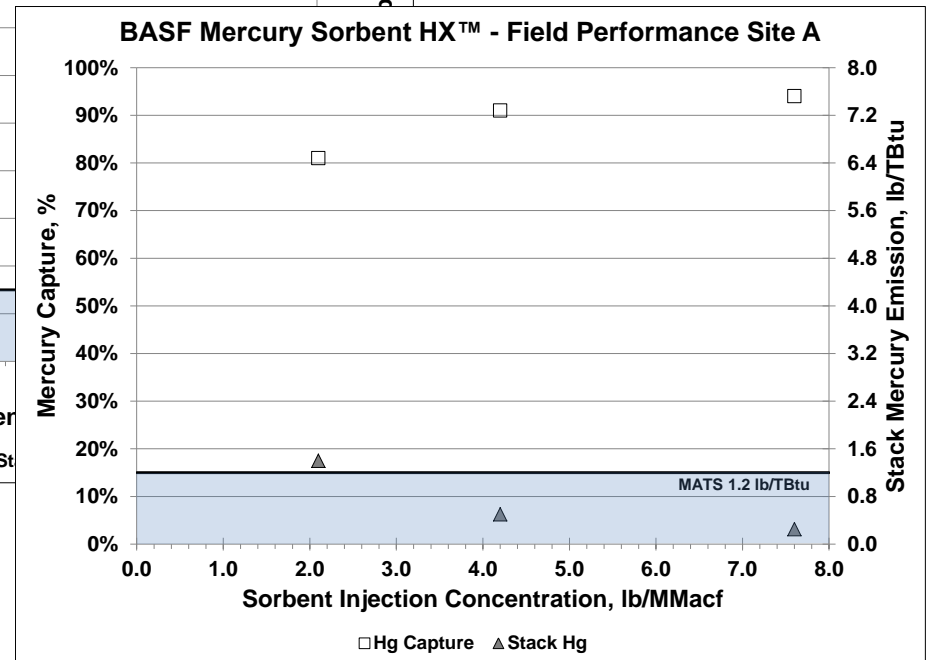
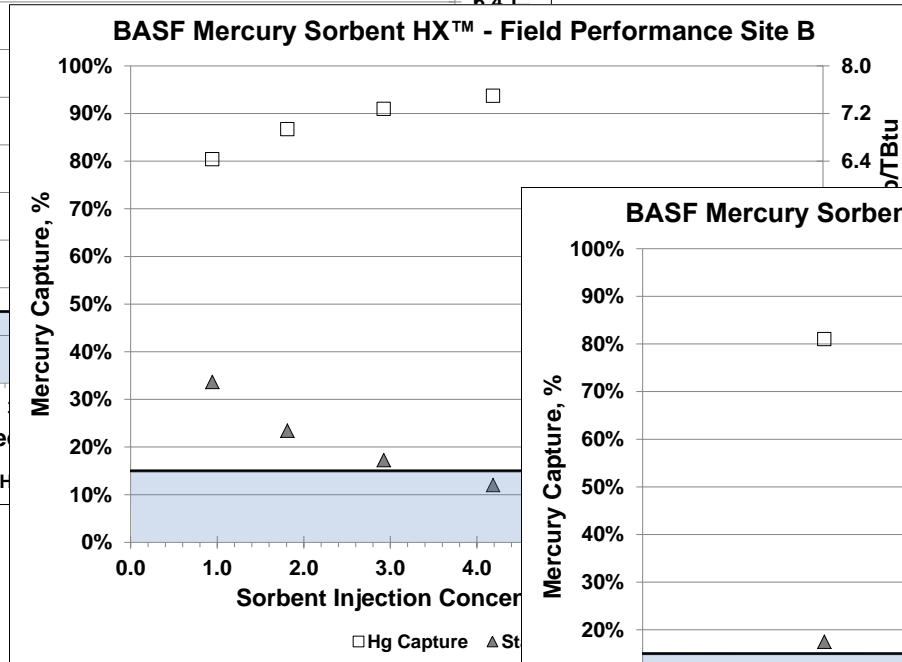
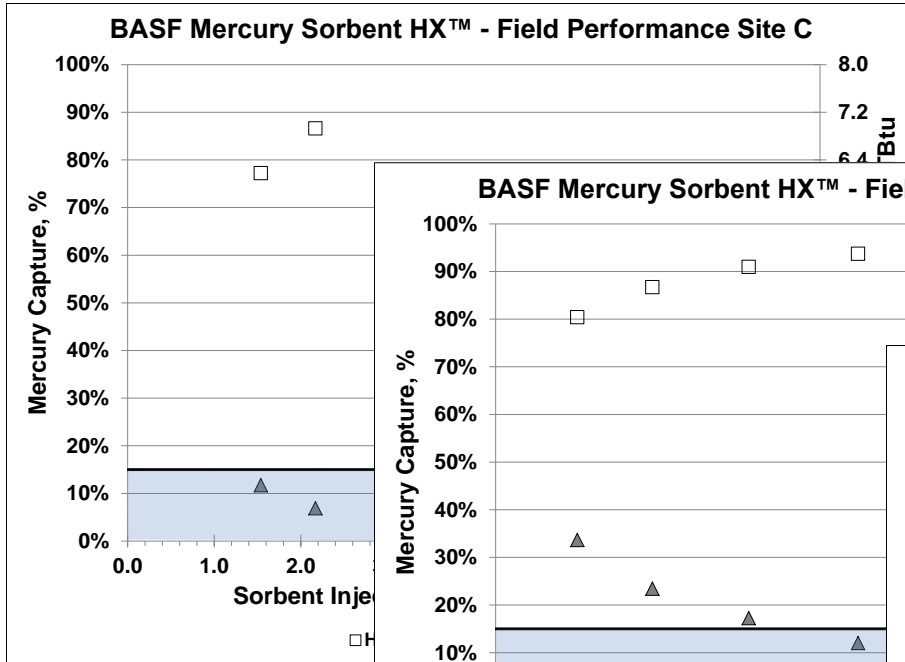
Parametric injection of Mercury Sorbent HX™

- Parametric curve based on hourly average mercury emissions
- Responsiveness confirmed that Mercury Sorbent HX™ flowed well through an injection system nominally designed for PAC



Mercury Sorbent HX™ demonstrated an established pattern of compliant performance

Site C – PRB+FF
Site B – PRB+ESP
Site A – PRB+ESP



ASTM C 457 metrics determine concrete compatibility of mercury sorbents in fly ash

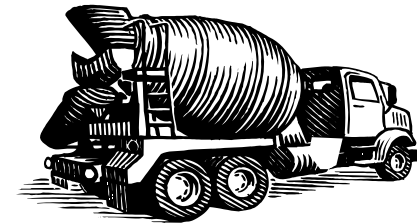
Concrete Sample Mixes

Cement Source	Lehigh Mitchell Type I/II	
Cement, lb/yd ³	450	451
Fly Ash (Source)	Class C (Site A)	
Entrained Mercury Sorbent	None	BASF Mercury Sorbent HX™
Sorbent in Ash	n/a	1%-wt
Fly Ash, lb/yd ³	113	113
Replacement, %	20	20
Sand, lb/yd ³	1343	1344
Stone, lb/yd ³	1753	1755
Water, lb/yd ³	254	254
AEA*	BASF MasterAir® AE 90	
AEA* (oz/cwt)	1.60	2.20

[* AEA = Air Entraining Admixture]



...after initial mix

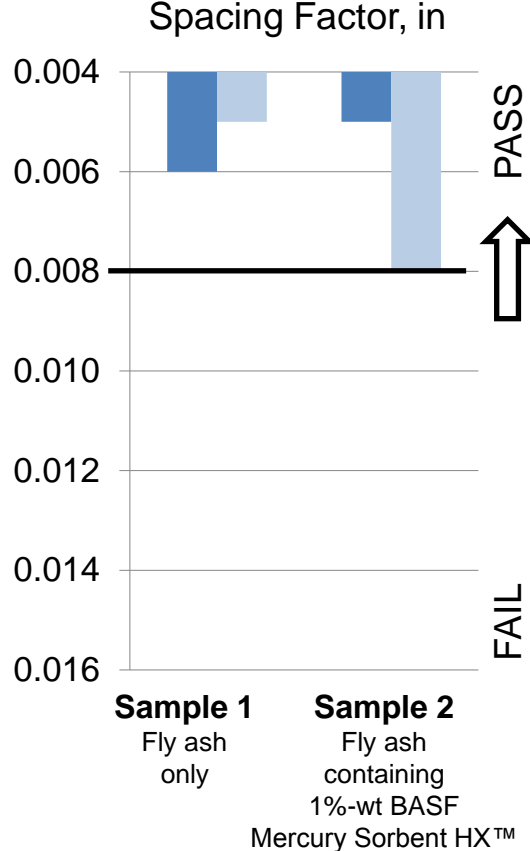
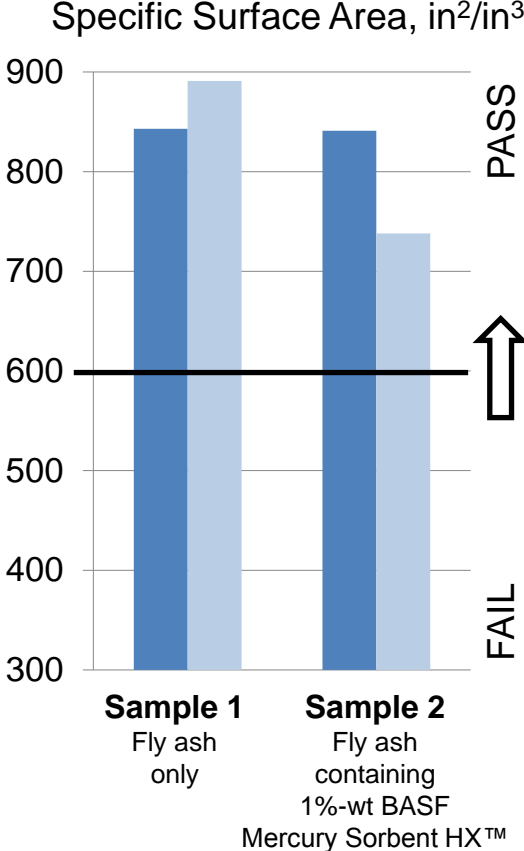
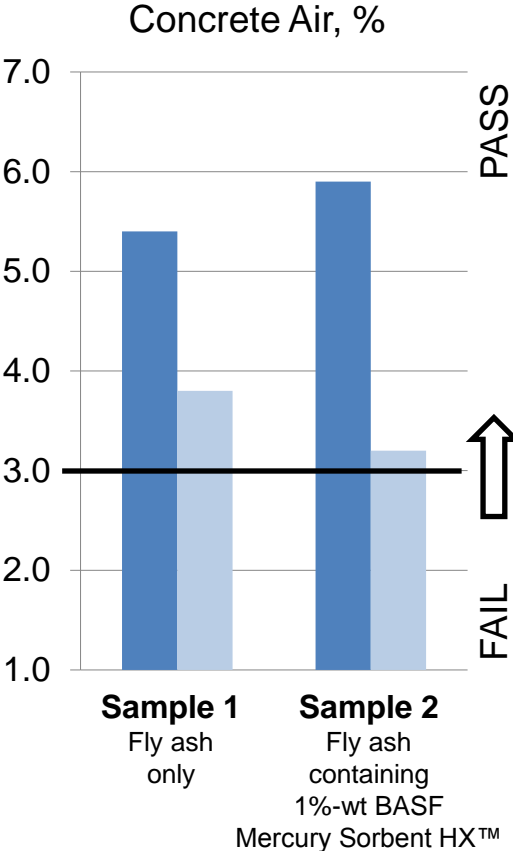


...after 60 minutes agitation



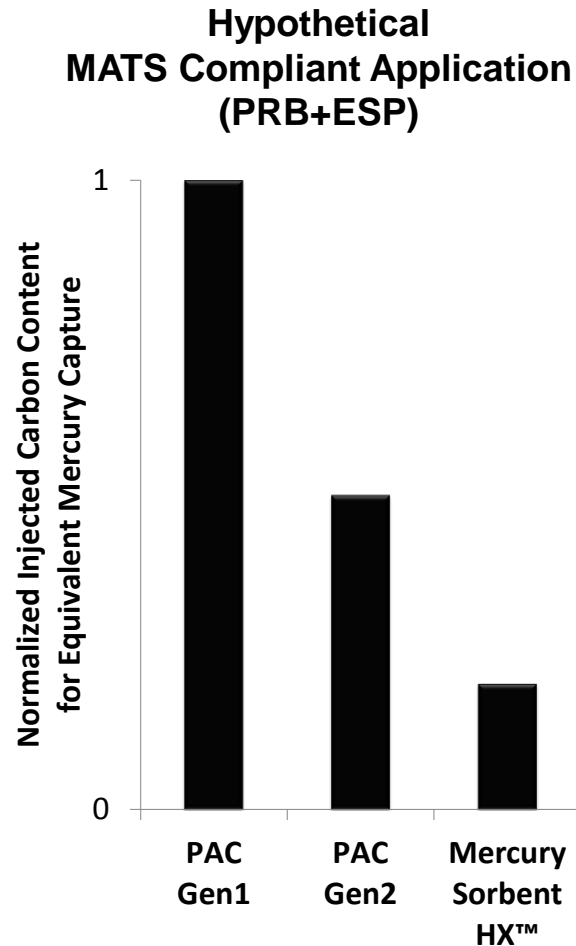
Right amount of air voids?	Right size of air voids?	Right spacing of air voids?
Concrete Air Volume	Specific Surface Area	Spacing Factor
≥ 3%	≥ 600 in ² /in ³	≤ 0.008 in

Fly ash mixed with Mercury Sorbent HX™ demonstrated stable entrained air properties



After Initial Mixing
 After 60 Minutes Agitation
 Threshold Value

Mercury Sorbent HX™ is a “low carbon in the fly ash” solution for MATS



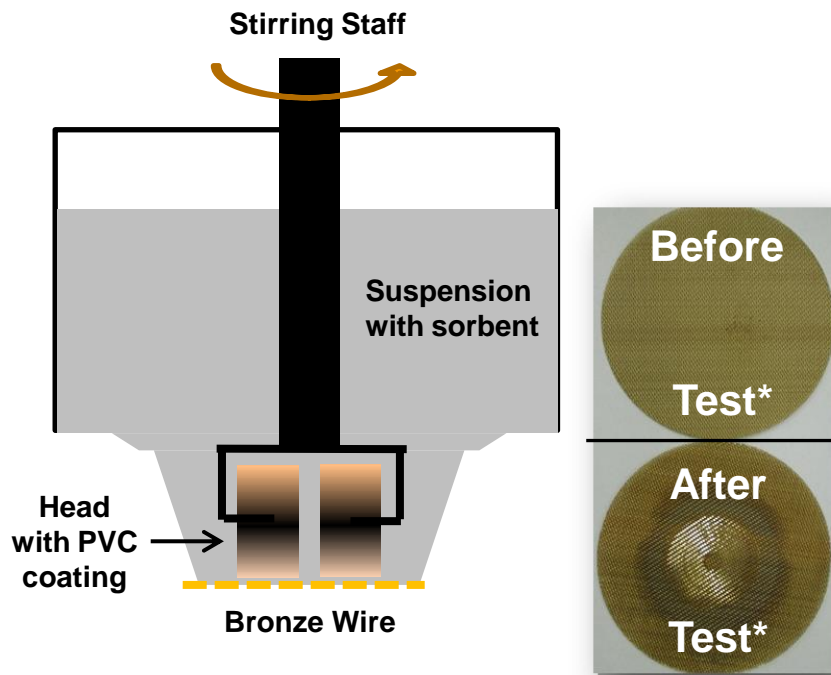
- Mercury Sorbent HX™ achieves mercury MATS compliance at an injected carbon level significantly lower than even the latest generations of PACs
- As a novel solution that balances mercury control and fly ash quality, the Mercury Sorbent HX™ patent has been allowed by the United States Patent and Trademark Office (12/2013)

Note: Relative values based on comparative study of published technical literature for PRB coal-fired units equipped with a cold-side ESP.

Low carbon = Low abrasion

Mercury Sorbent HX™ less abrasive than PAC

Einlehner Abrasion Test*



- Pneumatic transport of mercury sorbents may cause abrasion and erosion of the conveyance system over time

Material	mg_loss / 100k revolutions
Mercury Sorbent HX™	13.8
PAC	53.8

- Mercury Sorbent HX™ is almost 4 times less abrasive than PAC

Key metric: weight loss of bronze wire disc per fixed number of revolutions
Higher values = More abrasion

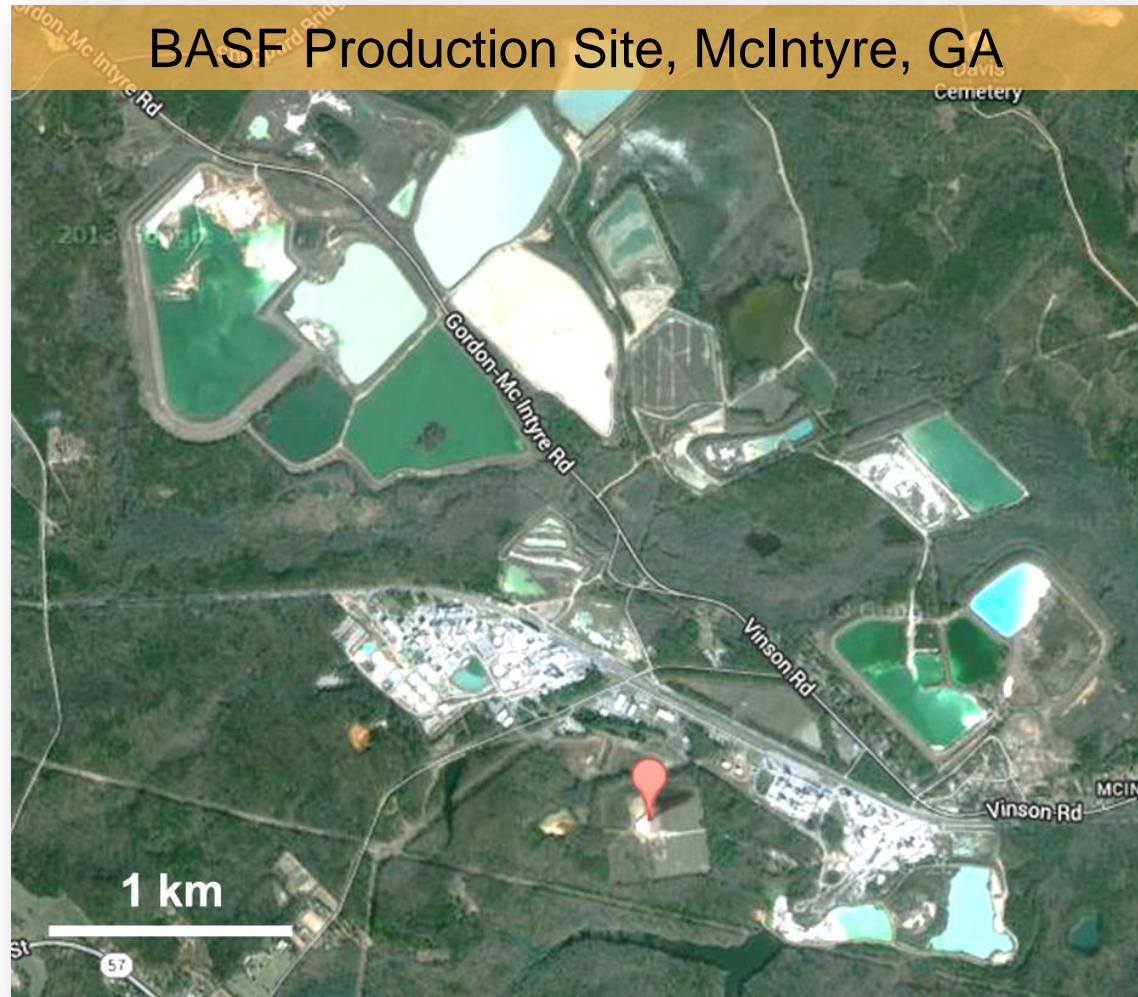
[* Generic test photos; for illustration purposes only]

Summary

- Mercury Sorbent HX™ consistently delivers high mercury removal to achieve MATS compliant mercury emissions
 - Demonstrated on both electrostatic precipitator and fabric filter equipped units
- Mercury Sorbent HX™ differentiates itself as a “low carbon in the fly ash” solution for mercury emissions compliance
 - Preserves the salable properties of fly ash for concrete applications
 - Petrographic analysis confirms air-void system for freeze-thaw durability
 - Less abrasive material than PAC

BASF, ready to supply...

- In 1908, kaolin operations began in McIntyre, Georgia and have grown over the years to yield 4 plants and numerous mines
- BASF leverages its expertise in materials science to provide a unique innovative solution for mercury capture
- BASF works closely with the utilities in the organization of their trials
- Mercury Sorbent HX™ can be supplied in supersacks, trucks, or trains



Questions / Acknowledgment



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