


“Update on Sorbent-Based Mercury Control in Hot-Side ESP Environments”



Sorbent Technologies Corporation

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Brominated Powdered Activated Carbon

B-PAC



Introducing: Brominated PAC or B-PAC™

- traditional PACs with an inexpensive bromination step
- permanently sequesters both elemental & oxidized Hg
- faster Hg kinetics than PACs for use in cold-side ESPs
- wide temperature operating range for use in hot-side ESPs
- already halogenated for use with Western coals
- multiple patents pending



Full-Scale DOE Subbituminous/ESP Trial: B-PAC at Detroit Edison's St. Clair Station

Southeast Michigan

Cold-Side ESP

330°F

85 Sub/15 Bitum. Blend

80 MW

700 (470) ft²/K acfm

0.06 ppm

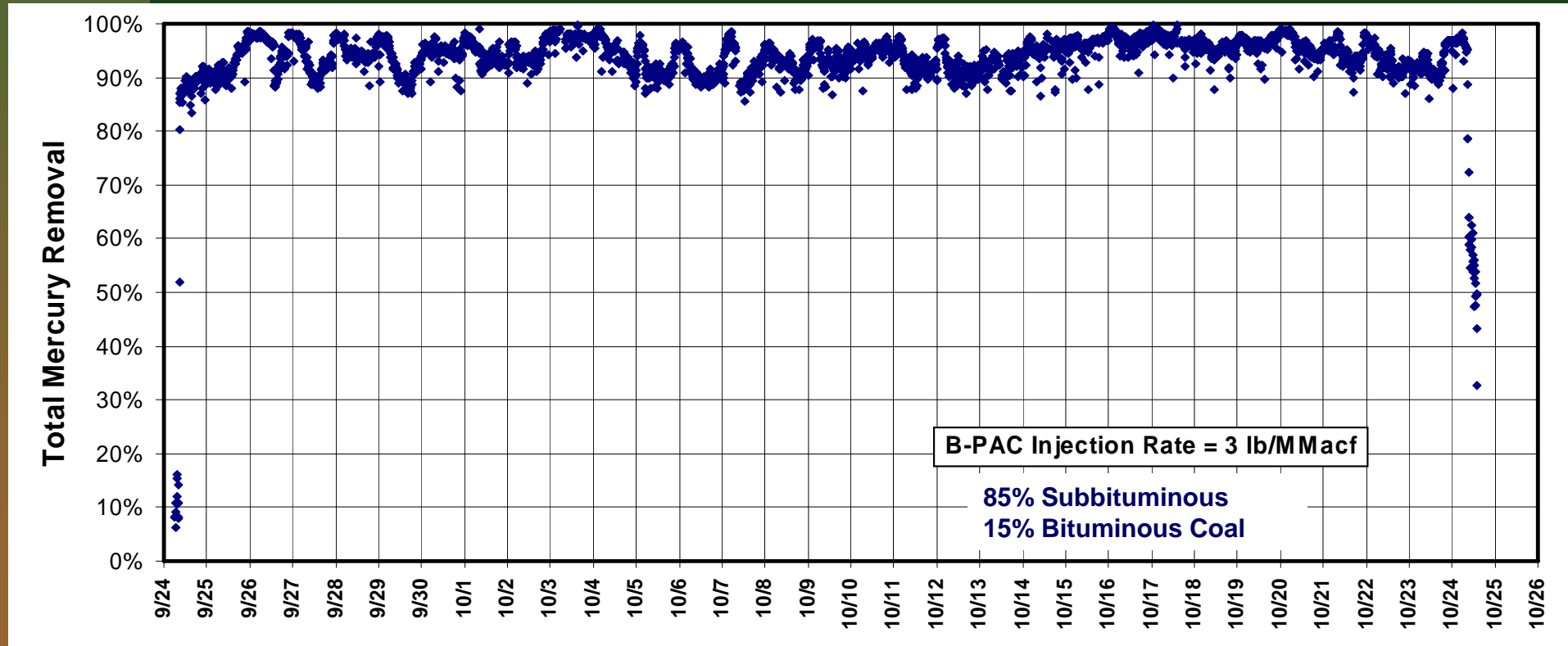
Mostly Hg⁽⁰⁾





Long-Term B-PAC Run at St. Clair Plant


Thirty-Day Average Mercury Removal at St. Clair = 94%





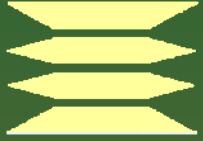
B-PAC™ is Now Commercially Available





Brominated Powdered Activated Carbon

Hot Side Experience



Parametric Testing at Duke/Cliffside

- Baseline and Parametric testing was performed in cooperation with the DOE at Duke Energy/Cliffside Unit #2
 - Hot Side ESP
 - 700°F Inlet gas temperature
 - Split ESP
- More detailed plant data and photo on the following slide



Hot-Side Testing at Duke's Cliffside Plant



Coal Type:	Low-S Bitumin.
Boiler:	No. 2 (Unit 2)
Boiler Type:	Tangential
Particulates:	Hot-Side ESP
ESP Stream Size:	40 MWe
ESP Inlet Temp.:	700°F
SCA :	240 ft ² /K acfm
Avg. Coal Hg:	0.08 ppm
Avg. Coal Cl:	500 ppm



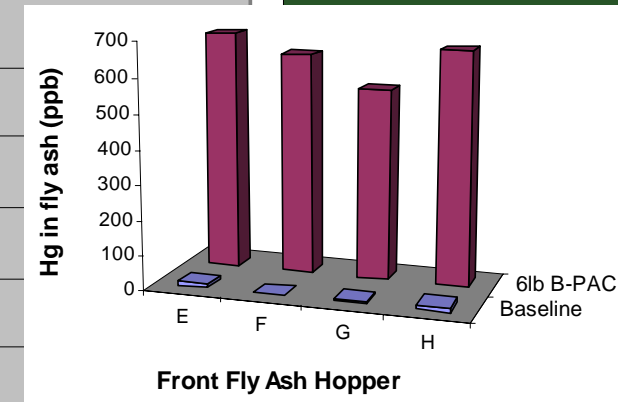
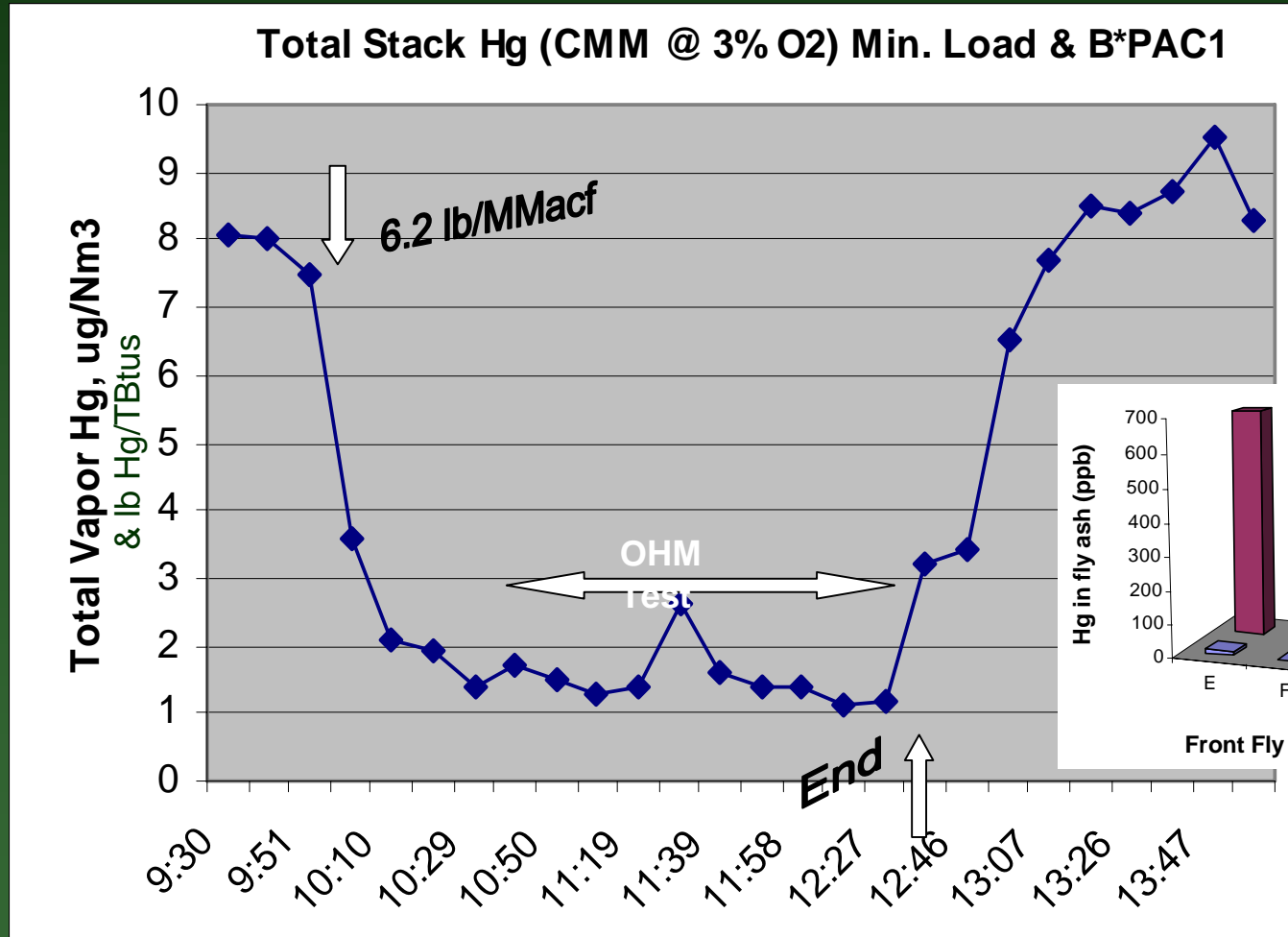
Hot-Side Testing at Duke's Cliffside Plant

- The following slides detail the results from our special Hot-side specific H-PAC:
 1. Over 80% mercury removal at two different injection rates
 2. Verification of removal by measured dramatic increase in ash hopper mercury
 3. No negative impact on ESP performance (in fact the opacity went down!)



Cliffside 2003 Results

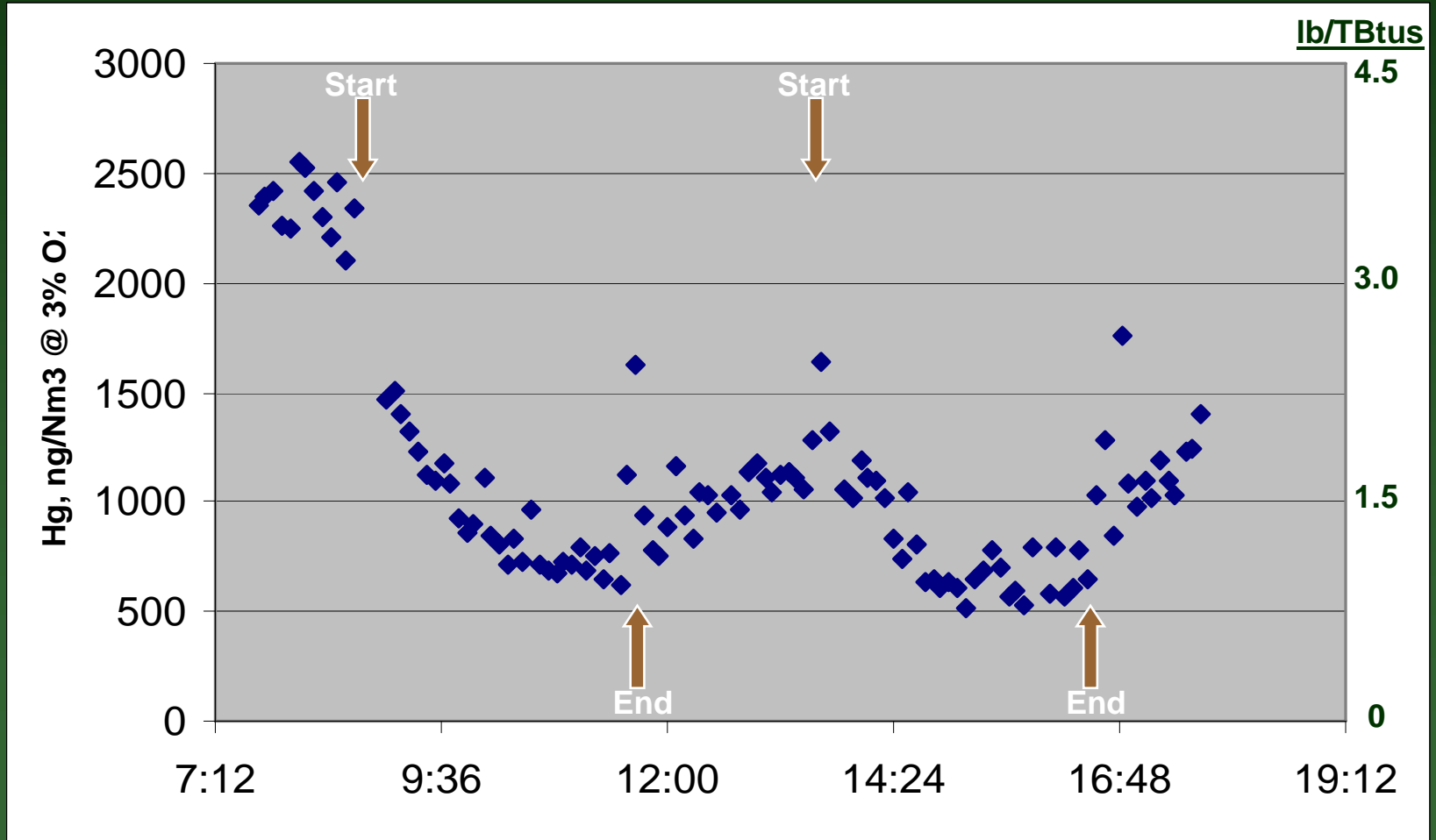
H-PAC at 6.2 lb/MMacf





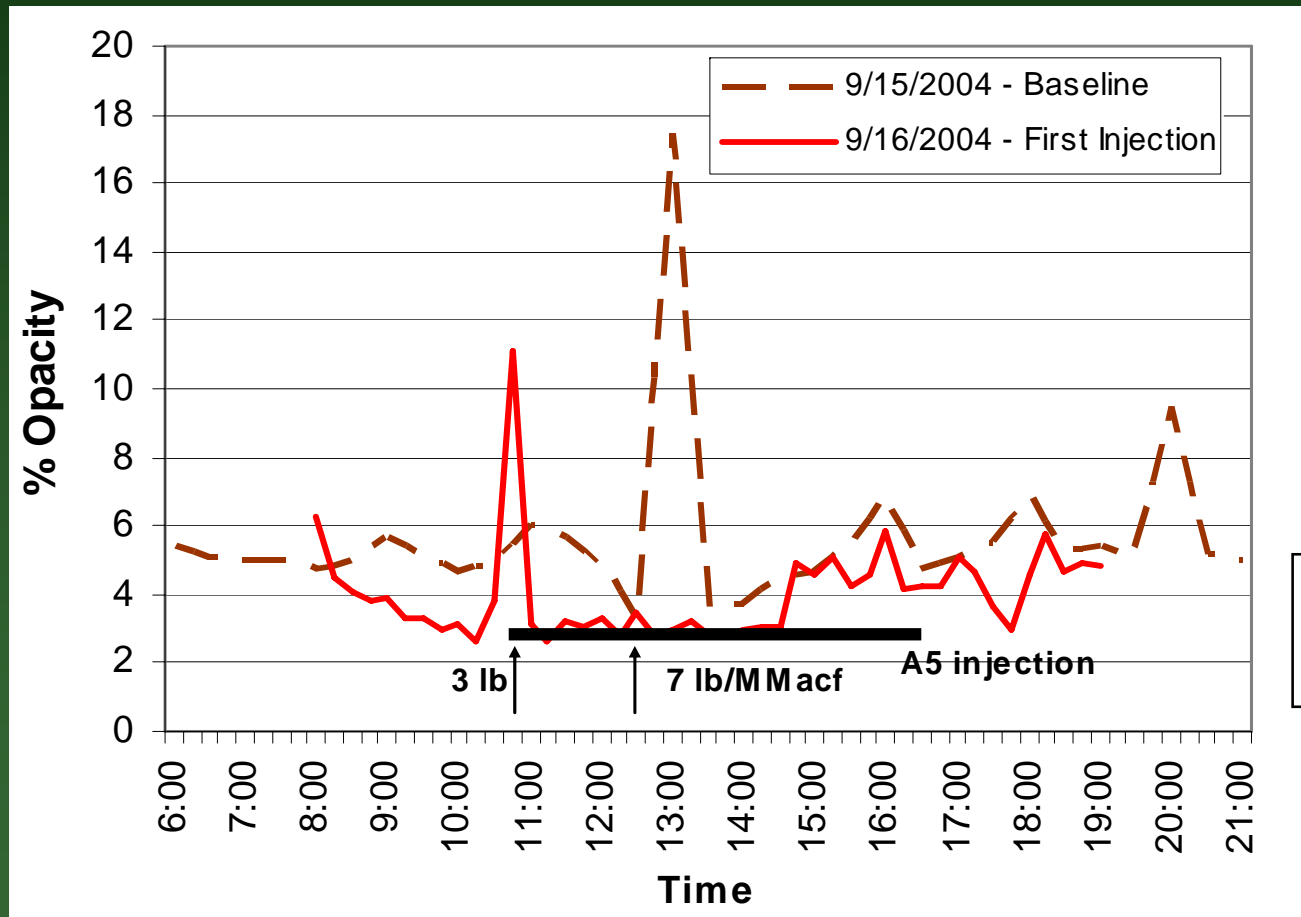
Cliffside 2004 Results – Two B-PAC Sorbents

H-PAC at 5.0 lb/MMacf @ Min. Load





Balance-of-Plant Effects: Opacity



SCA=240 ft²/K acfm



Duke Energy – Buck Plant – Hot-Side ESP

North Carolina

Hot-Side ESP

640°F Inlet

Low-S Bituminous

½ x140 MW (~100MW)

240 ft²/K acfm SCA

~ 0.06 ppm Hg

~ 5.4 µg/Nm³ @ O₂

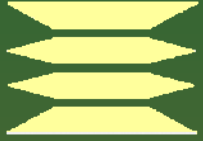
~ 60-80% Hg⁽⁺²⁾





Parametric Tests

- Parametric tests were conducted with two different versions of H-PAC, the detailed results are on the following page:
 - Mercury removal rate between 55% and 65%
 - Mercury removal rate with industry baseline PAC was less than 5% (typical for Hot-Side ESPs)



Parametric Tests

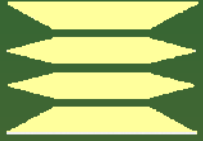
Preliminary Results

<u>Boiler Load</u>	<u>Inj.Temp.</u>	<u>lb/MMacf</u>	<u>H-PAC1</u> <u>% Removal</u>	<u>H-PAC2</u> <u>% Removal</u>
60 MW	540F	4.0	56%	65%
60 MW	540F	7.0	57%	63%
100 MW	590F	2.0	54%	44%
100 MW	590F	5.0	62%	N.D.
100 MW	590F	7.0	63%	62%
140 MW	640F	7.0	64%	54%
140 MW	640F	7.0	3%	Norit FGD



Preliminary Conclusions from Parametrics

- **Essentially no native Hg removal (Hot-Side Typical!)**
- **Essentially no Hg removal with plain PAC (Also Hot-Side typical)**
- **Generally 50-65% removal at 2-7 lb/MMacf with both H-PACs**
- **Gas temperature & load appeared to have little affect**
- **Hg removal appeared to plateau with injection rate**



Long Term Testing

- 30 Days, but periodic shutdowns
 - boiler tube leak, 2 flameouts, etc. not related to sorbent injection but typical of day to day events in a typical power plant
 - coal went to ~20% ash
 - some inertial-separator or analyzer outages
 - boiler switched to low-NOx mode/OFA
 - switched inlet monitoring to untreated outlet
 - M324s + 3 days of Apogee co-measurement + OHMs
 - Data on following Chart



Long-Term Test

Preliminary Results

- H-PAC1 injected at 5 lb/MMacf (~ 3.5 lb/MMacf)

<u>Load</u>	<u>Inj.Temp.</u>	<u>Ib/MMacf</u>	<u>Time Fraction</u>	<u>Wtd.Avg. %Remov.</u>	<u>Ib/TBtus</u>
60 MW	~ 540F	5.0	28%	49%	3.0
140 MW	~ 640F	5.0	50%	50%	3.0
60 MW	~ 540F	10.0	22%	71%	1.8



The B-PAC & H-PAC Were Supplied in Bulk

- Our first B-PAC™ plant can serve numerous power plants





Future DOE B-PAC, C-PAC, & H-PAC Demos



(plus additional short-term non-DOE trials at other utility sites)



Conclusions

1. Judging from the 2004 DOE full-scale results at St. Clair (& Meramec, Holcomb, & Stanton 10) a high level of retrofit Hg control with subbituminous coal & N.D. lignites appears relatively easy, inexpensive, & is available today.
2. While ACI is more difficult with hot-side ESPs, with Brominated PAC it is indeed possible.



Thank you!

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