REINHOLD ENVIRONMENTAL Ltd.

2010 APC Round Table
& Expo Presentation

July 18-20, 2010, in Concord, NC / Hosted by Duke Energy

ALBEMARLE® | Sorbent Technologies

Case Studies of Cost Comparisons for Mercury Reductions

Sid Nelson Jr.

2010 Reinhold APC Conference

Largest U.S. Bromine Producer

Sell both Brominated PACs
(B-PAC™, C-PAC™) & systems
- and -
$CaBr_2$ or other bromides

Wisconsin Public Service - Weston 4

- **NSPS Boiler**
- **Subbituminous coal (Jacobs Ranch PRB)**
- **SCR & Spray Dryer/FF**
- **Permanent ACI for Hg**

Acknowledgement

Mercury Control Optimization Study
Wisconsin Public Service Co – Weston Unit 4
November 19, 2009

Mercury Control Optimization Study

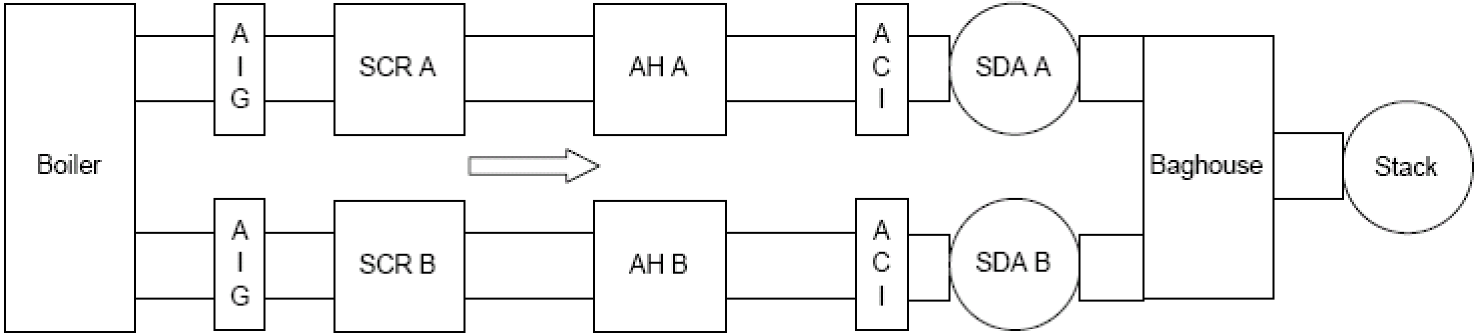


Figure 1. Schematic of Weston Unit 4.

ALBEMARLE | Sorbent Technologies

Alternate Sorbent Tests

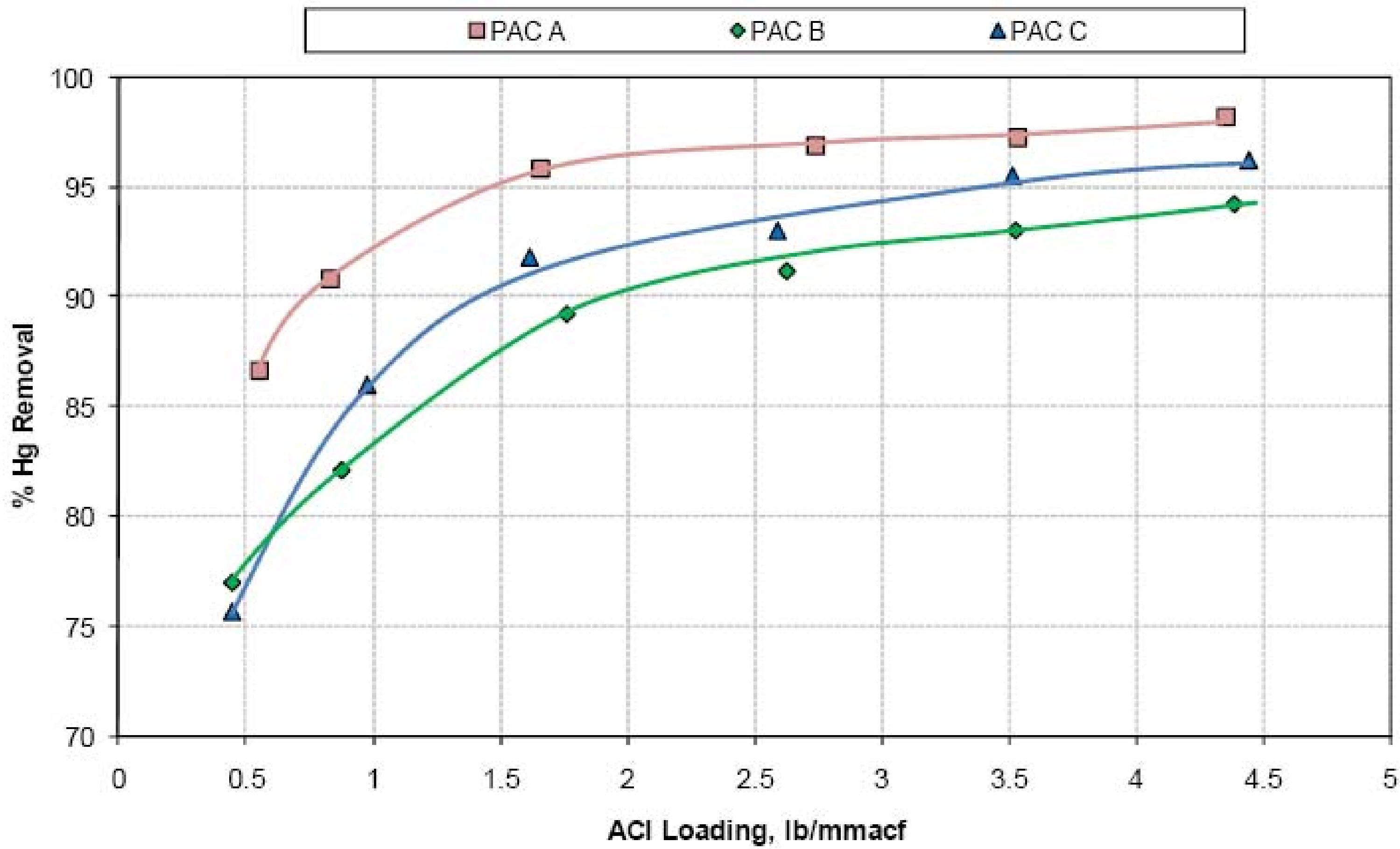


Figure 23. Mercury Removal for the Parametric Test with Alternate Sorbents.

Alternate Sorbent Tests

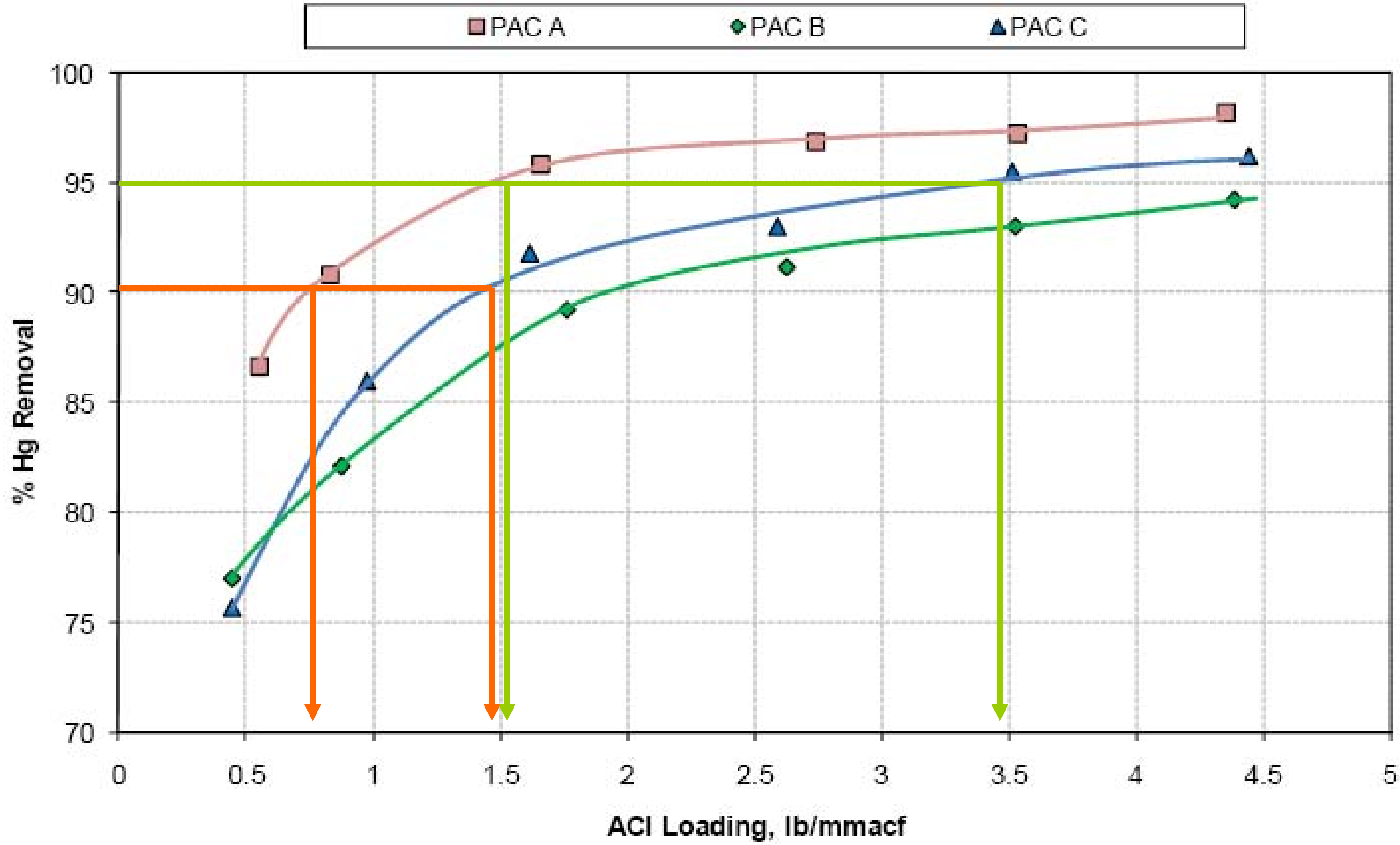


Figure 23. Mercury Removal for the Parametric Test with Alternate Sorbents.

Orange & lime added.

ALBEMARLE® | Sorbent Technologies

Comparative Sorbent Tests

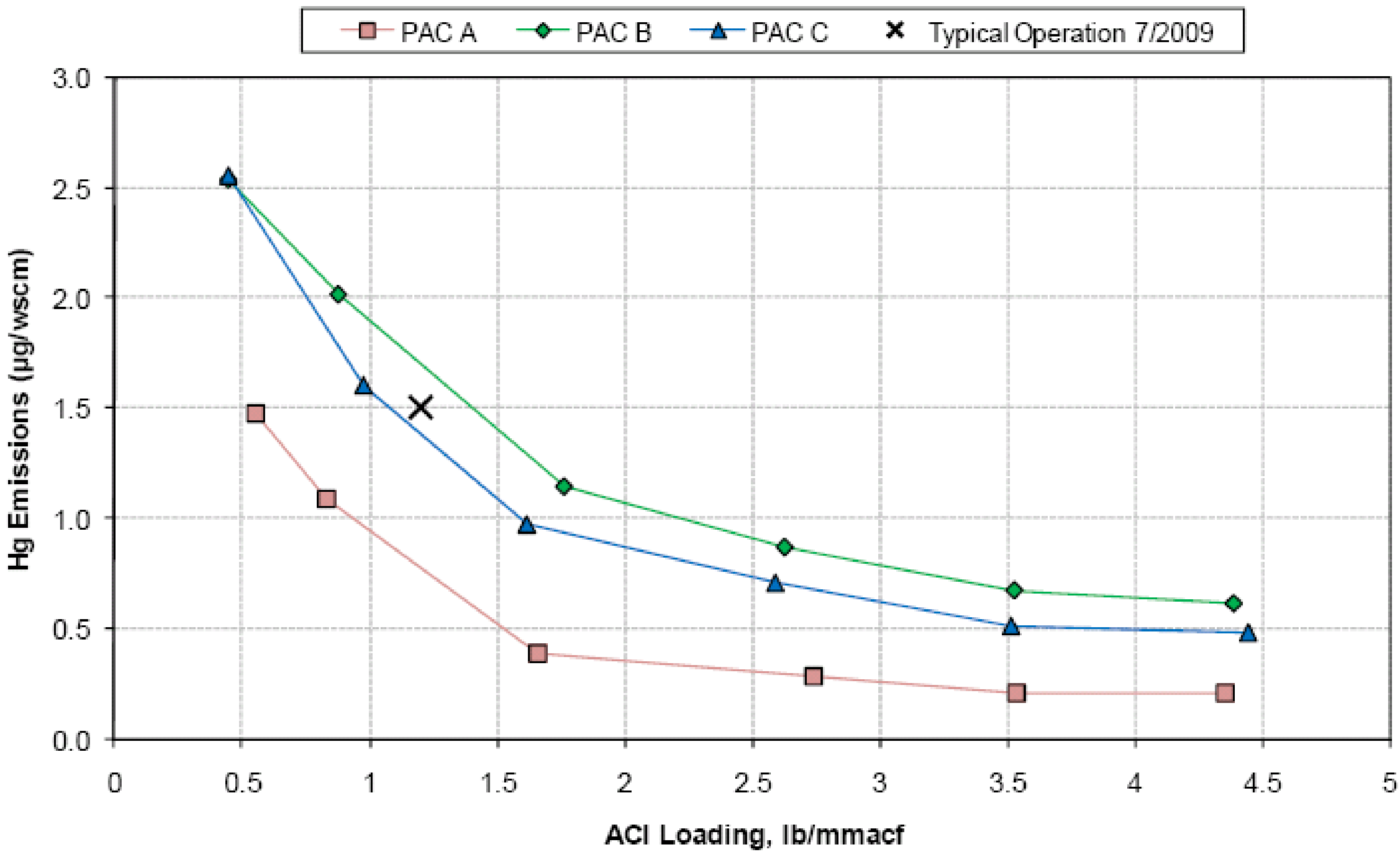


Figure 24. Mercury Emission for the Parametric Test with Alternate Sorbents.

Comparative Sorbent Tests

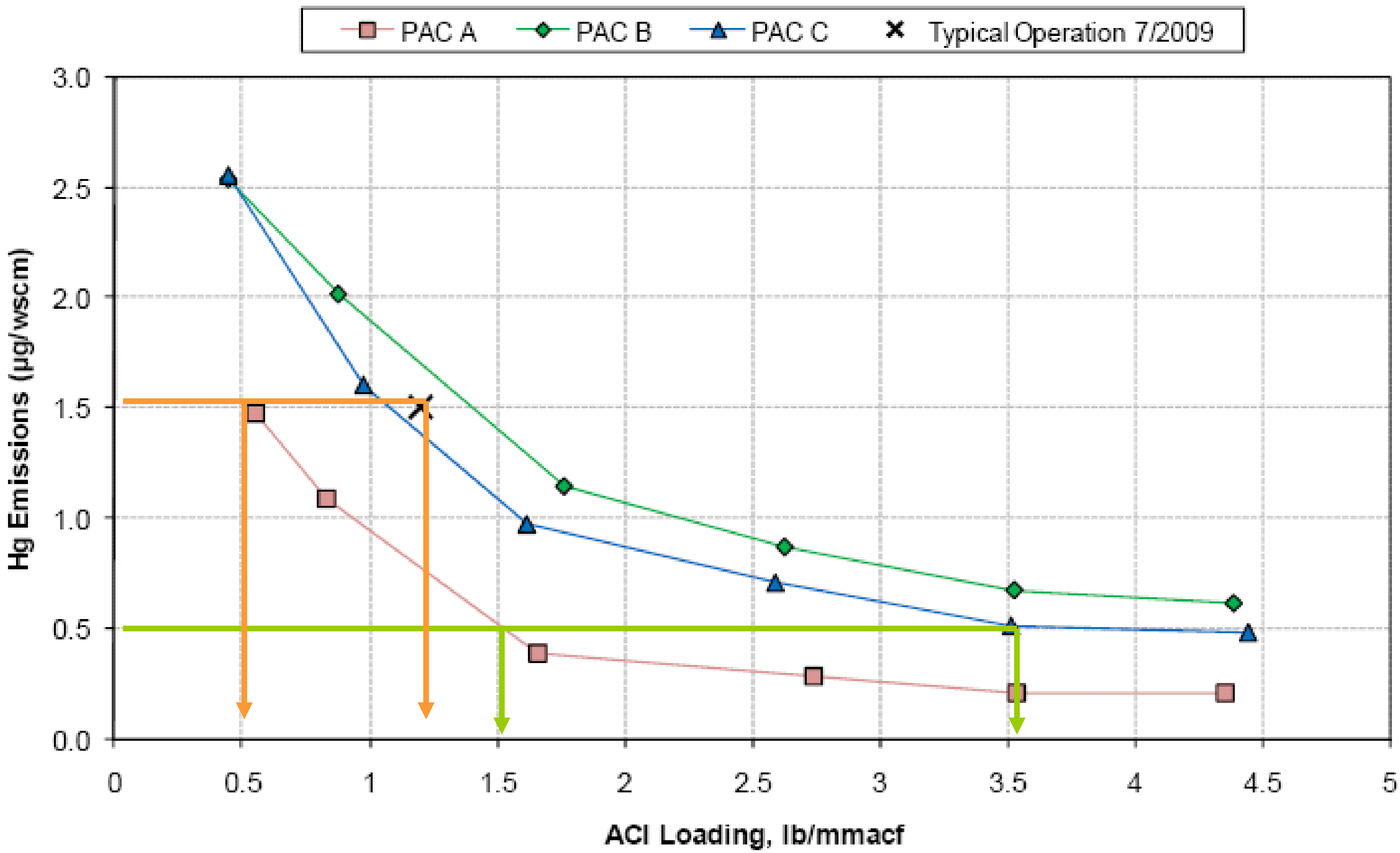


Figure 24. Mercury Emission for the Parametric Test with Alternate Sorbents.

Orange & lime added.

Cost Calculations

To achieve 0.50 lb/TBtu Hg emissions with 1.5 lb/MMacf of B-PAC™:

$$\left(\frac{1.5\, lb\ PAC}{MMacf}\right)\left(\frac{540\ MW}{}\right)\left(\frac{3000\ acf}{\min MW}\right)\left(\frac{60*24*365*0.80 \min}{yr}\right)=$$

= 1,000,000 lb of PAC A per yr
= $1,250,000 /yr at $1.25/lb

If 3.5 lb/MMacf of PAC C are required for 0.50 lb/TBtu of Hg
= 2,400,000 lb PAC C per yr
= $2,400,000 /yr at $1.00/lb

Hg Sorbents Are Different

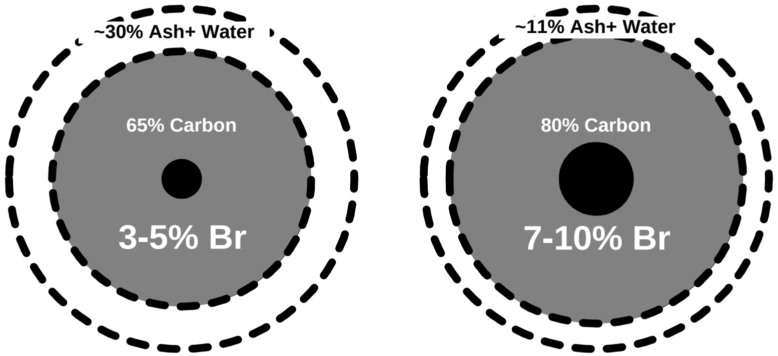
PAC Feedstock: lignite, bitumin., anthr., wood, coconut

Production: multi-hearth, kiln, slip furnace

Bromination: salt, gas-phase

Bromine Level: 4 wt% to 10 wt%

Ash Levels: 5% to 25%



→ **Not surprising that we can observe very different performance**

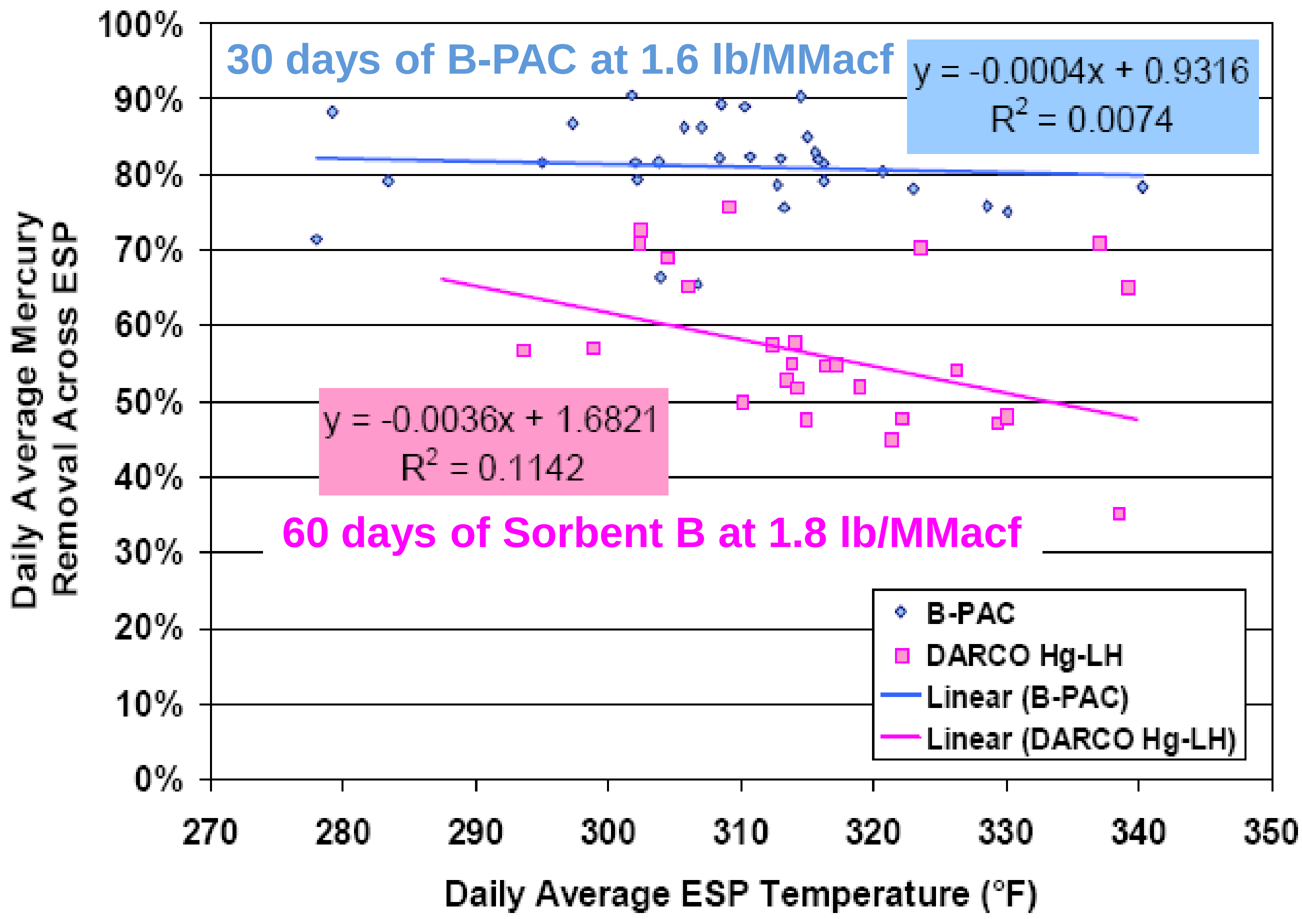
→ **Also differences in flow characteristics, thermal stability, electrostatic properties, concrete-friendliness™, & prices**

ESP Case: GRE's Stanton 1

- **PACs injected into a cold-side ESP**
- **150 MW, no FGD**
- **PRB subbituminous coal**

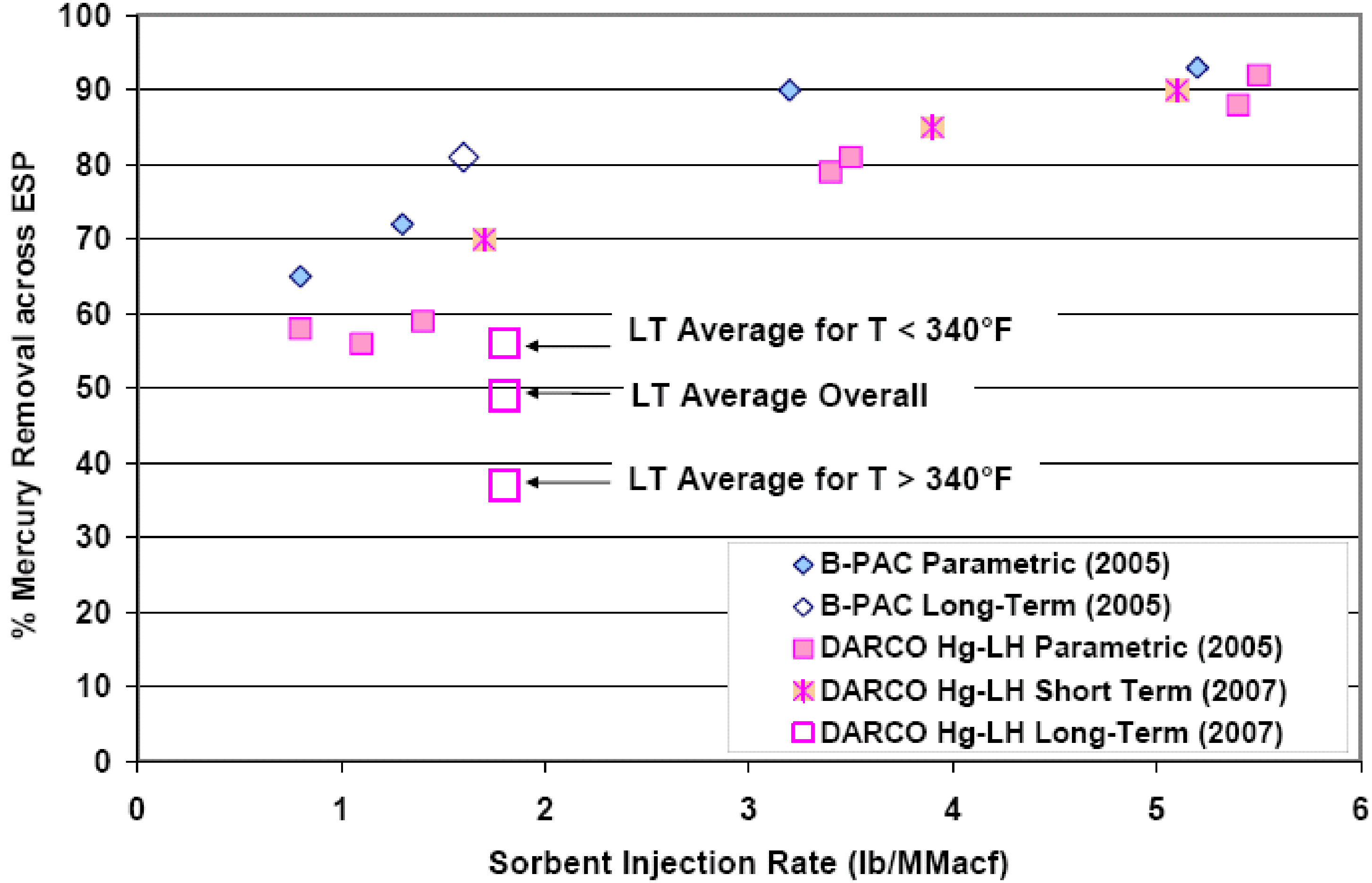
Source: Richardson, et al., URS Corp., "Evaluation of Novel Mercury Sorbents and Balance of Plant Impacts at Stanton Unit 1," 2008 Mega Symposium.

Comparative Sorbent Tests



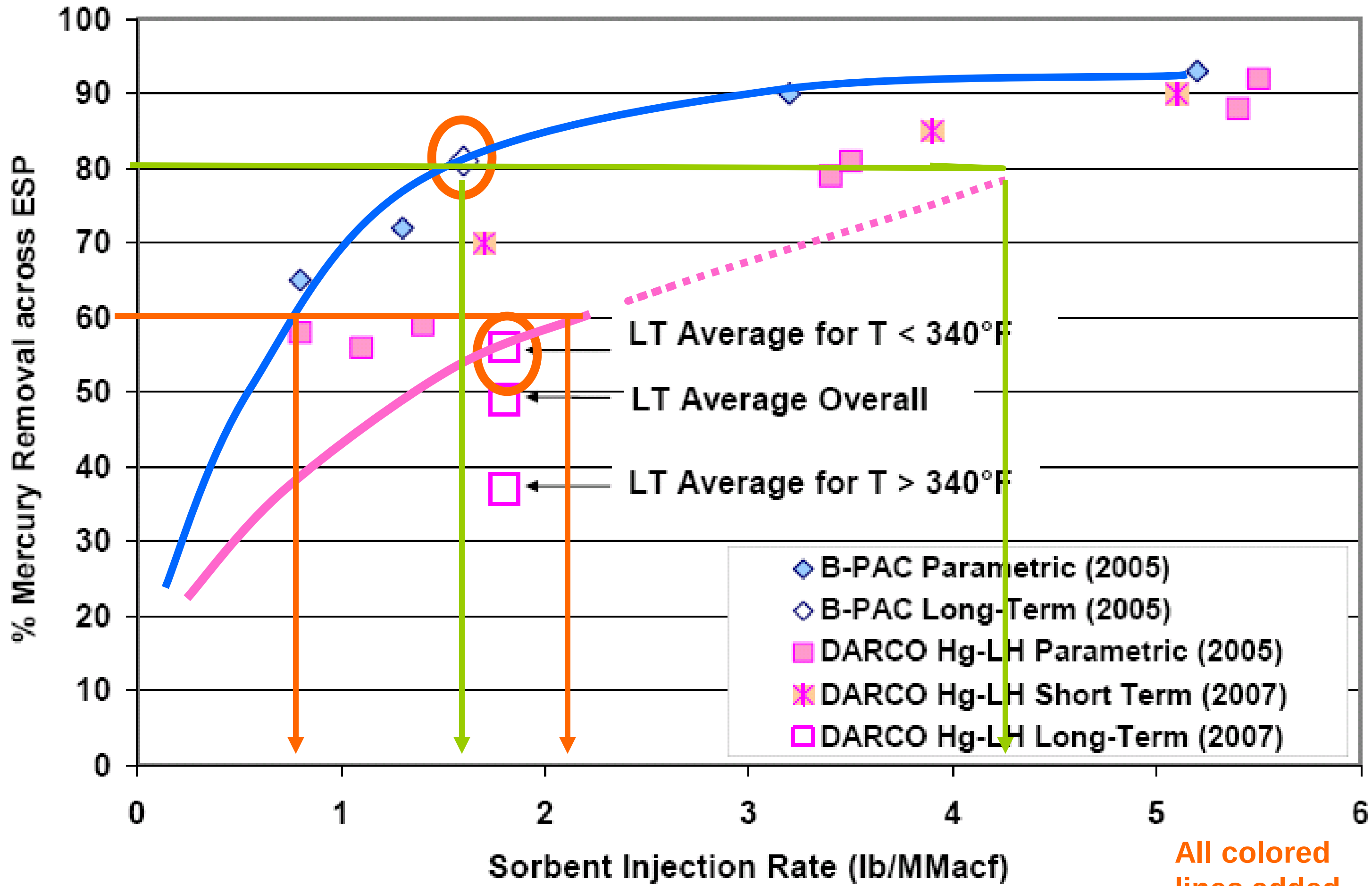
Colored wording added.

Comparative Sorbent Tests



ALBEMARLE® | Sorbent Technologies

Comparative Sorbent Tests



All colored lines added.

ALBEMARLE® Sorbent Technologies

Cost Calculations

To achieve 80% Hg reduction on 450 MW with 1.6 lb/MMacf of B-PAC™:

$$\left(\frac{1.60\ lb\ PAC}{MMacf}\right)\left(\frac{450\ MW}{}\right)\left(\frac{3000\ acf}{\min\ MW}\right)\left(\frac{60*24*365*0.80\ \min}{yr}\right)=$$

= 900,000 lb of B-PAC per yr
= $1,100,000 /yr at $1.25/lb

If 4.0 lb/MMacf of the other PAC is required for 80%
= 2,300,000 lb PAC C per yr
= $2,300,000 /yr at $1.00/lb

Take-Home Messages

- PACs are differently made with different materials and can exhibit significantly different performance levels & properties
- The lowest-cost PAC for your plant is not the lowest-cost per lb, but the one with lowest total costs to achieve your Hg goal
- Also consider other PAC properties: transport & plugging, ESP operation, thermal stability, & concrete effects
- Highly recommend full-scale, long-term, comparative trials at each unit & so don't wait until the last minute
- Albemarle supplies low-ash, high-bromine, highest-quality PACs, as well as domestic $CaBr_2$ & trouble-free injection systems