

Activated Carbon in Challenging Flue Gas Environments

Pure Water. Clean Air. Better World.



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Agenda

- **Introduction**
- **Calgon Carbon R&D Efforts**
- **Fluepac Advances/Advantages**
 - **Sulfur Tolerance**
 - **Concrete Friendliness**
 - **DSI Compatible**
- **Summary, Q/A**

Who Is Calgon Carbon Corporation?

- We are the world's largest producer of granular activated carbon
- We solve customer purification and separation problems with an array of technologies
- Activated carbon is our core competency with a diverse product portfolio
- Globally deliver over 400 MM pounds per year

240
PATENTS

23 OFFICES
SALES AND SERVICE

1100+
EMPLOYEES

15 FACILITIES
MANUFACTURING, REACTIVATION, EQUIPMENT

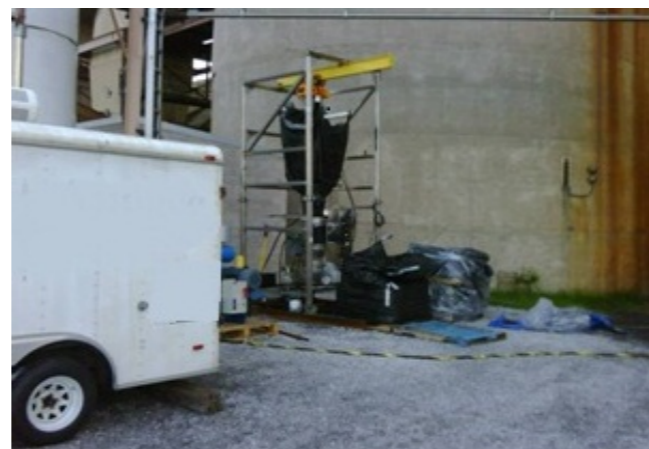
70+ YEARS
EXPERIENCE

\$548 million
2013 Net Sales



Market Leader in Research and Development

- Investment to date > \$12MM
 - Fluepac Product Development
 - Full scale product demonstrations and trials
- All test data generated by independent testing services
 - Independent Contractors – Injection skid, traps, and CEMS (TL and Super sack capabilities)
 - Element 1 Engineering, Apogee Scientific, and others
 - Transparent testing and “real time” data
 - MRC – 100s of product formulations tested for countless system variations



Non-Brominated Product Offerings

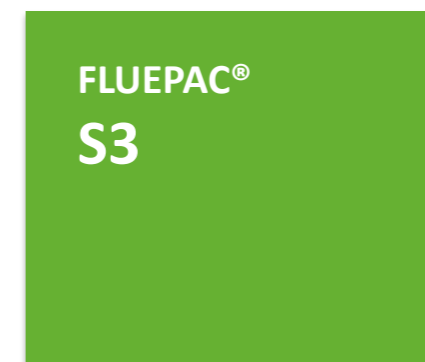
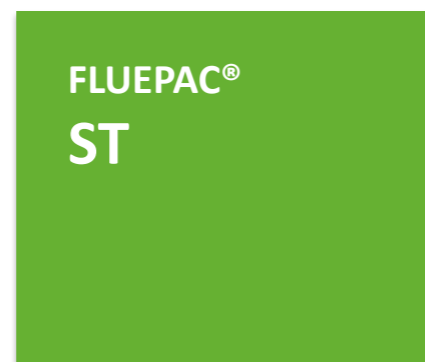
Standard

Advanced



Paired with Boiler
Additive/Refined Coal

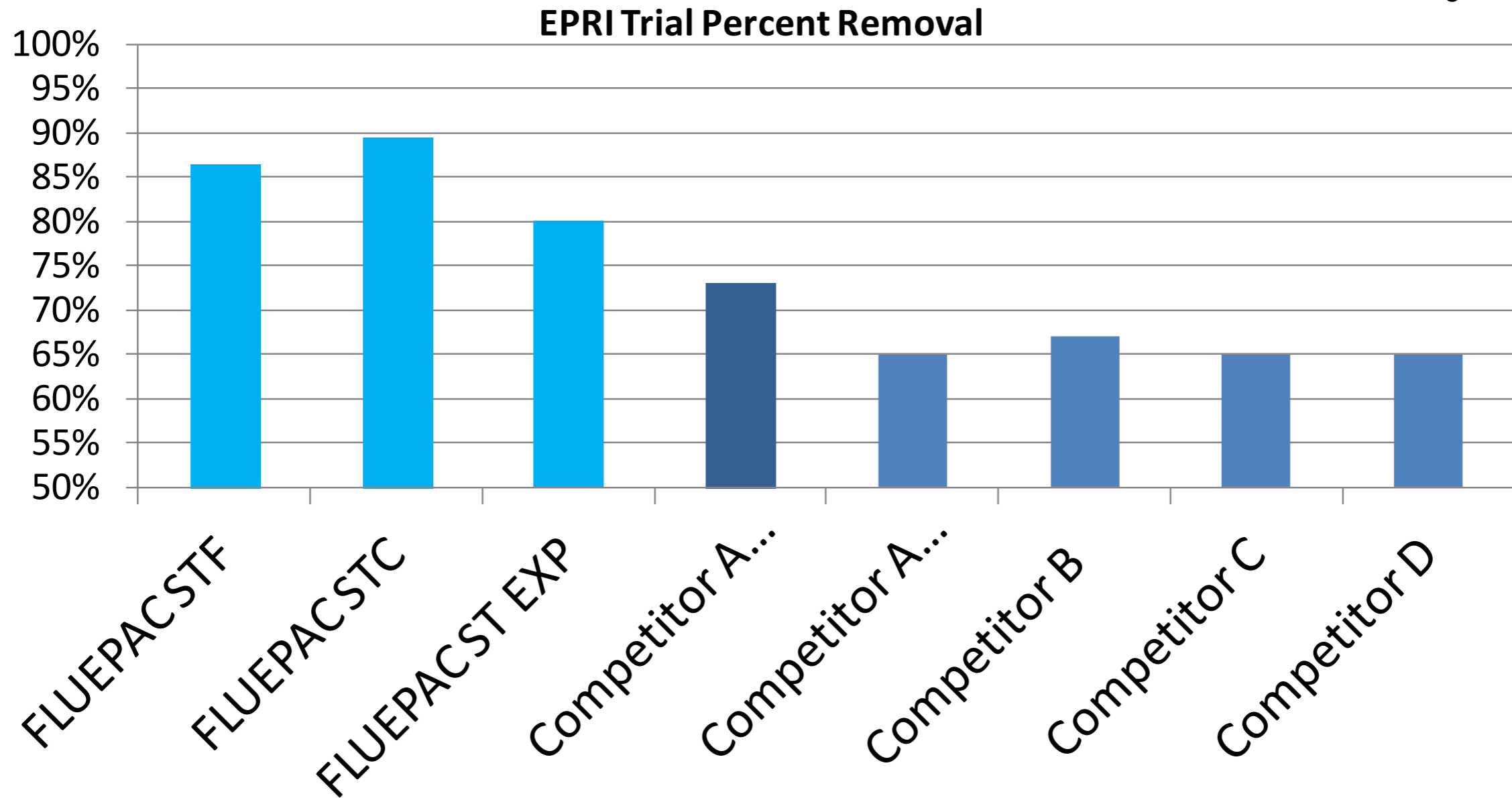
Brominated Product Offerings



Challenge 1: High-Sulfur Flue Gas Streams

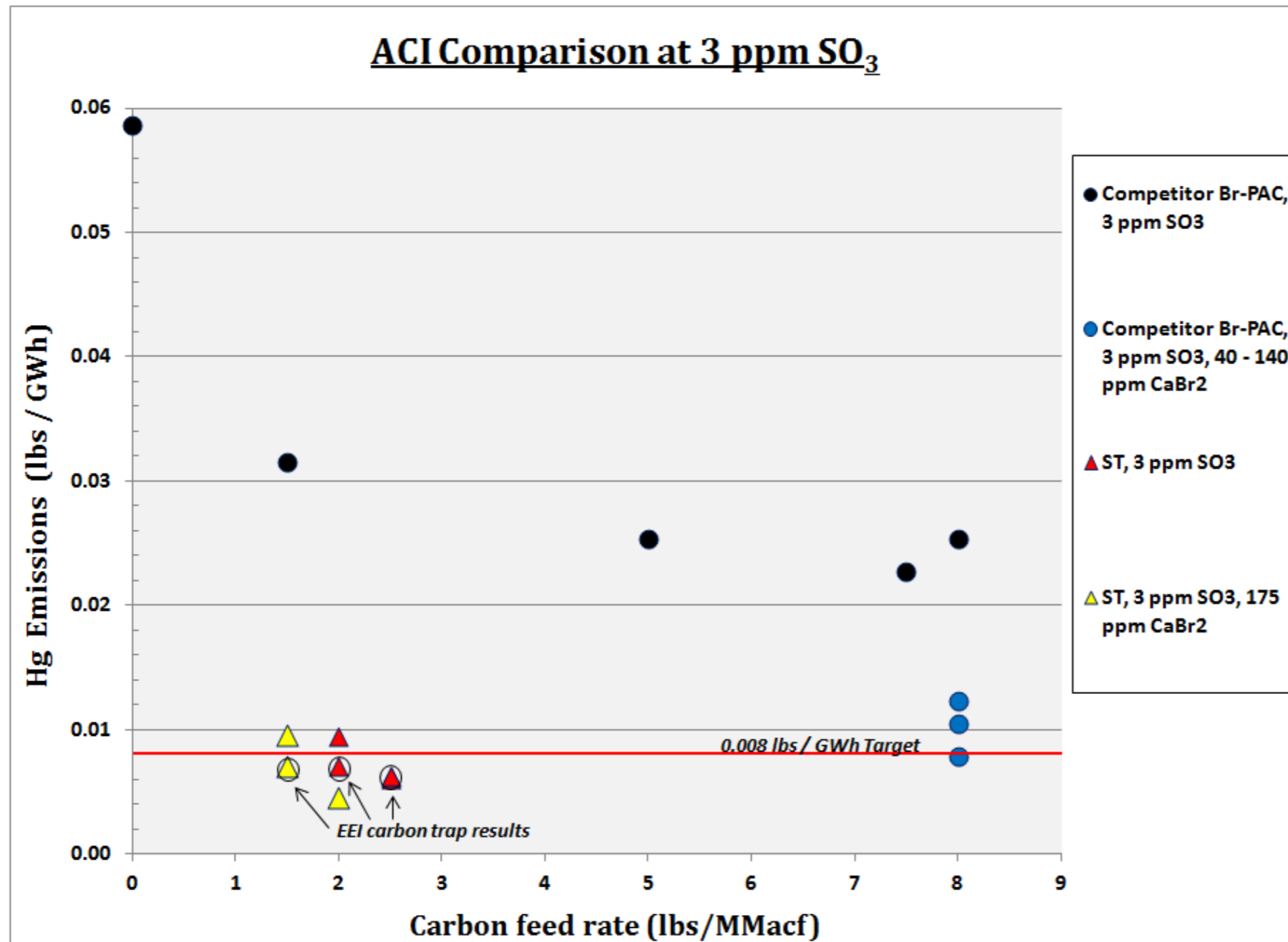
Calgon Carbon is #1 in SO₃ tolerance

September, 2013
5 ppm SO₃



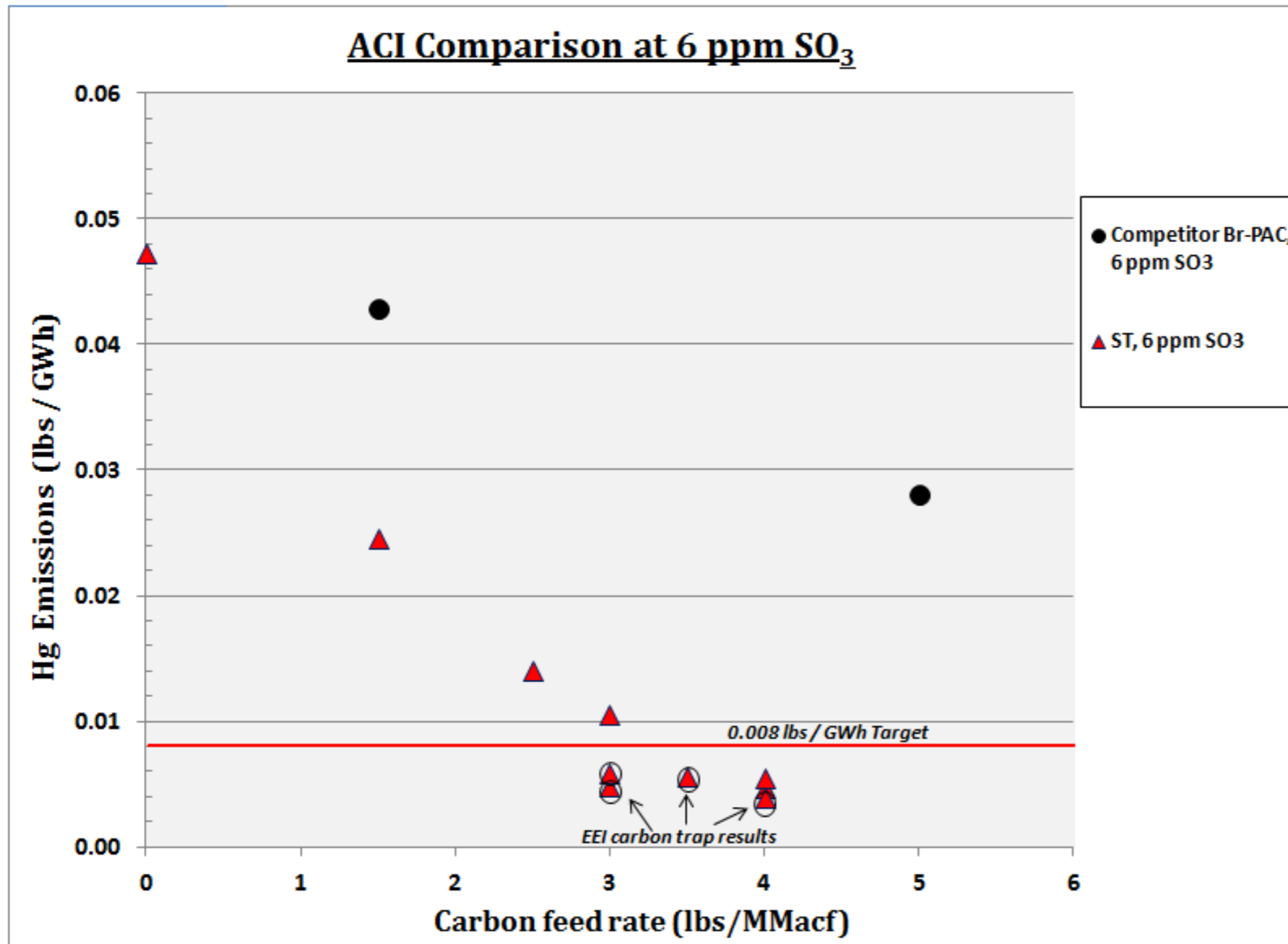
All carbons fed at same feed rate.

Full-Scale Utility Test with SO₃, 3 ppm



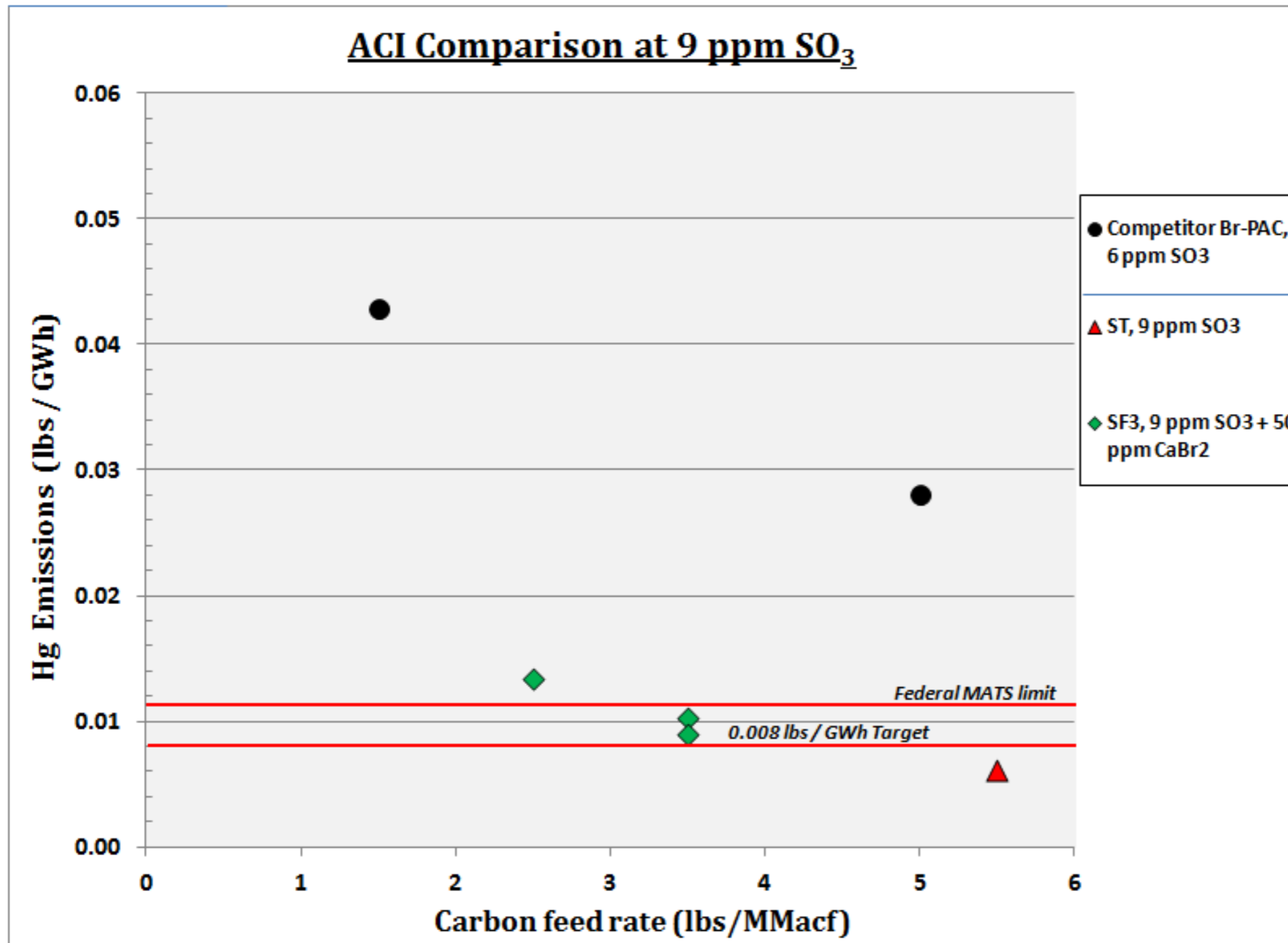
Fluepac ST achieved compliance at 75% reduced injection rate when compared to competitive Br-PAC without CaBr₂

Full-Scale Utility Test with SO₃, 6 ppm



At 6 ppm SO₃ Fluepac ST only required ~1 more lb/MMacf injection rate to reach compliance, while the competitive brominated product will not reach compliance at a reasonable rate with this configuration.

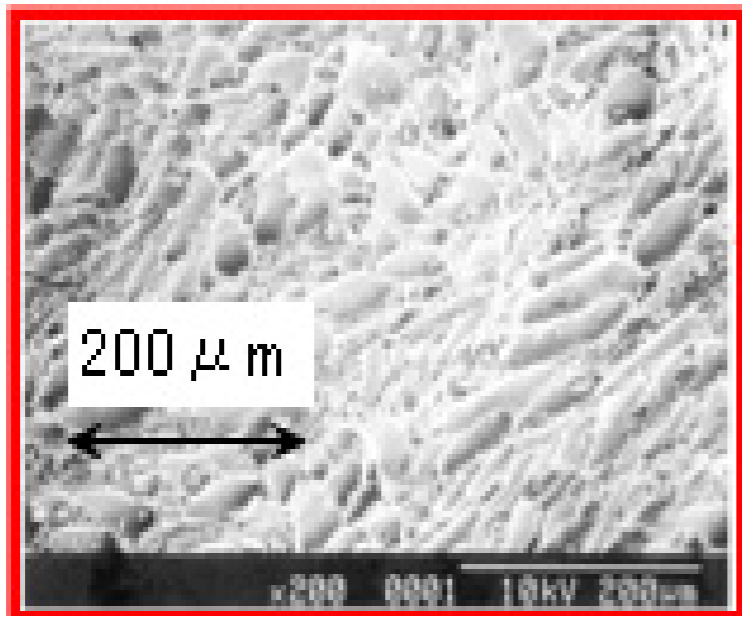
Full-Scale Utility Test with SO₃, 9 ppm



At 9 ppm SO₃ Fluepac ST was still able to achieve compliance at a reasonable injection rate. However, Fluepac SF3 achieved compliance easily. The competitive PAC was not tested at 9 ppm SO₃

Challenge 2: Fly Ash Quality – Concrete Friendliness

Foam Index – It's All About Porosity



2,000x magnification

Larger pores (meso & macro) readily adsorb large surfactant molecules

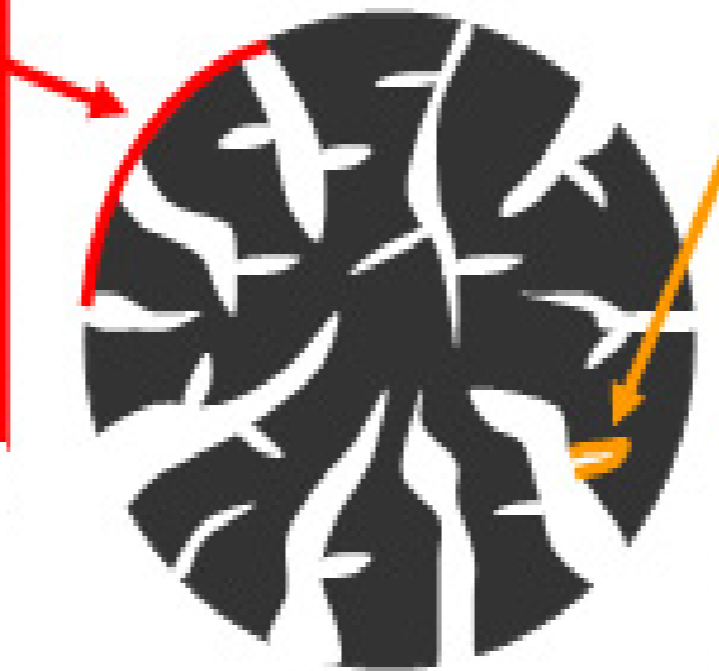
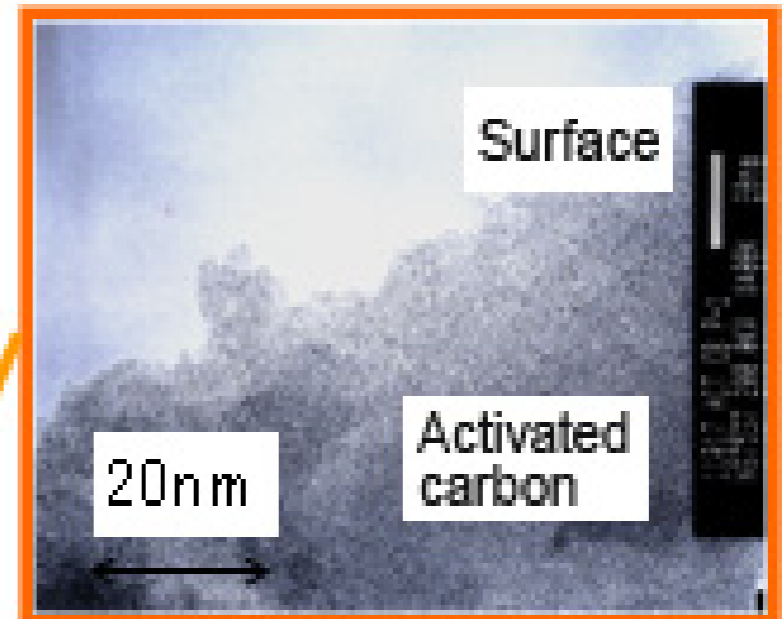


Image of pore



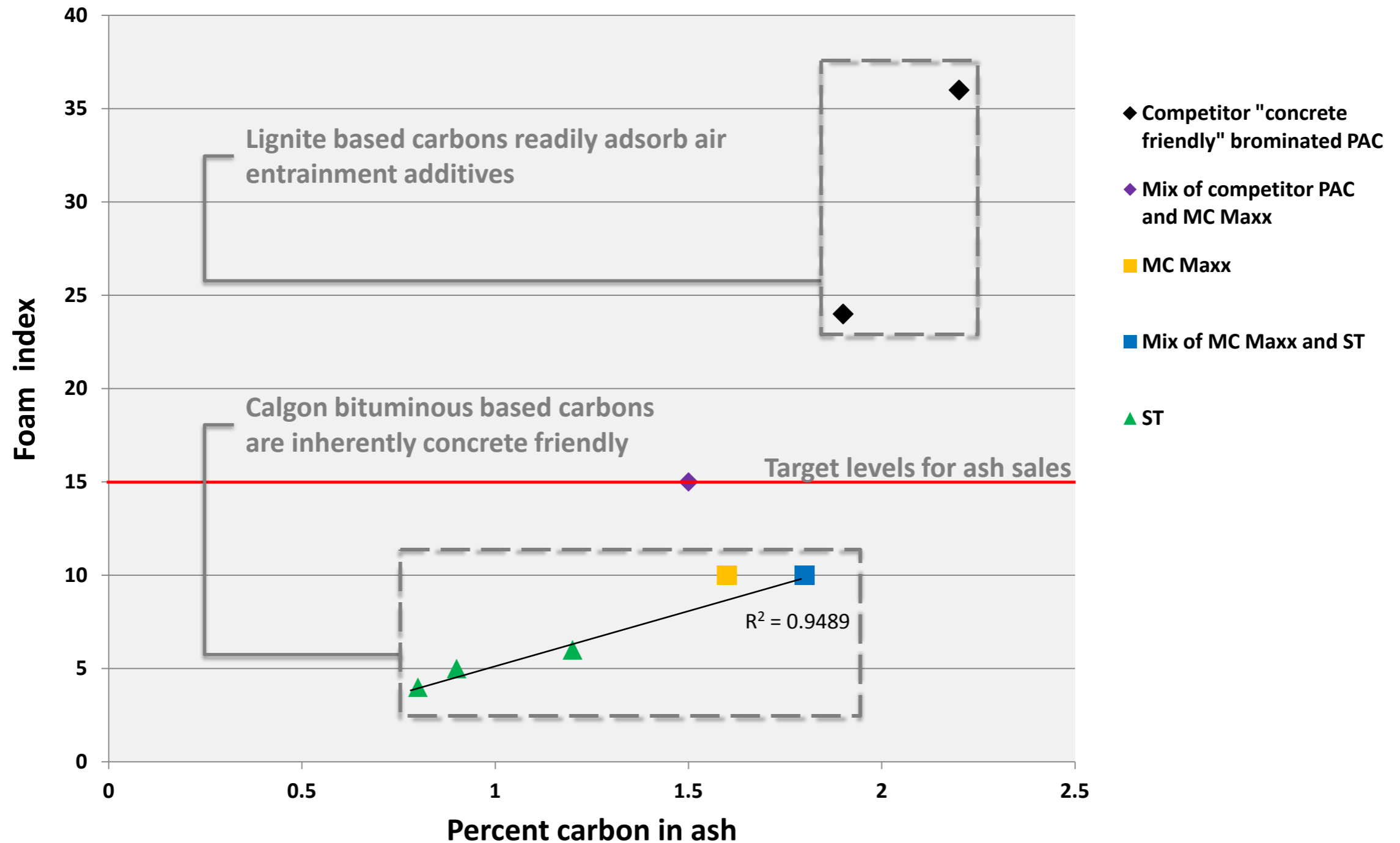
400,000x magnification

Micropores (<2 nm) cannot adsorb large surfactant molecules

A balance of micro and macro pores desired to maximize access to micropores (for mercury capture) and minimize adsorption of AEA's

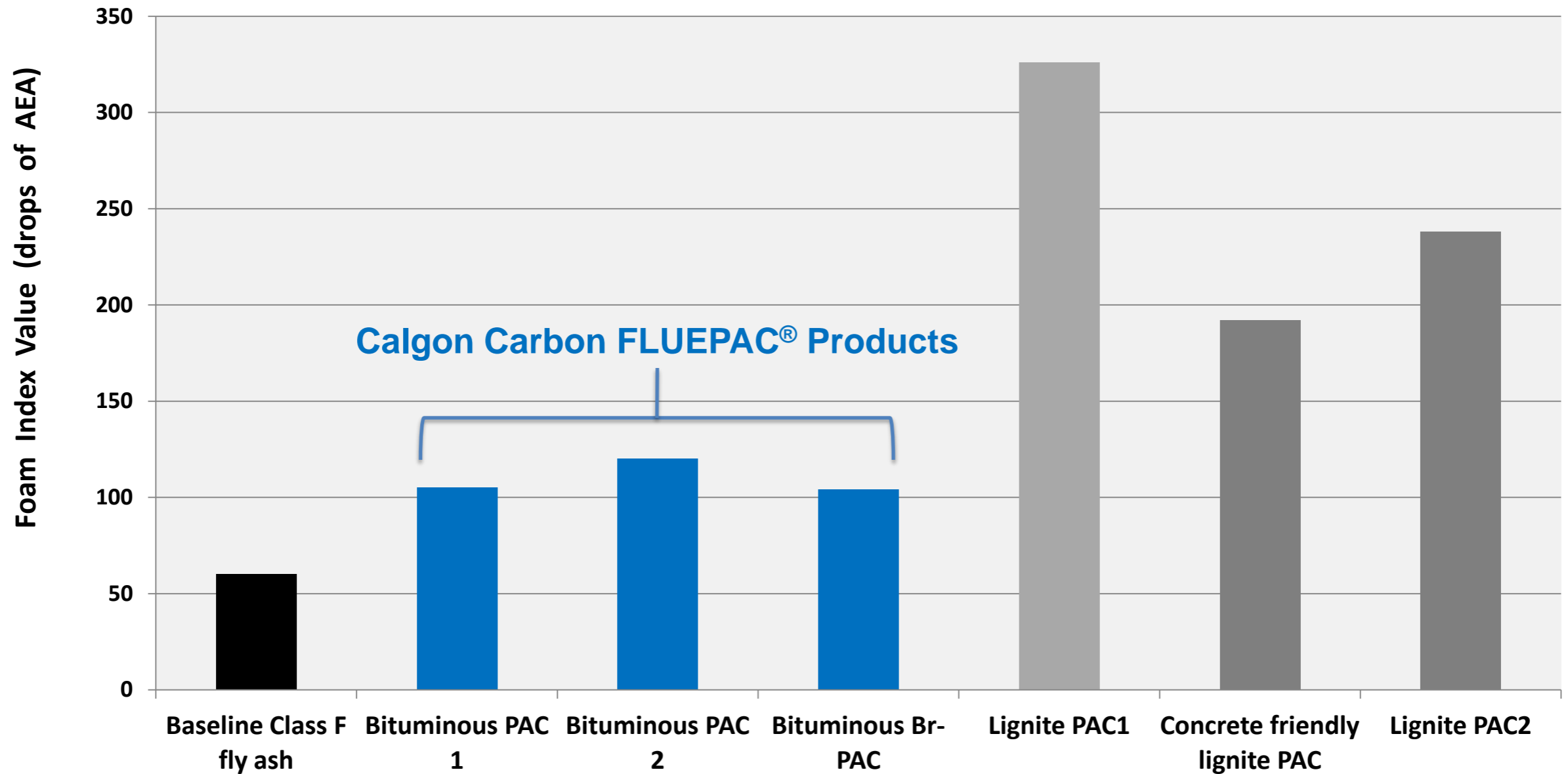
Fly Ash Sales Possible with Calgon Carbon Products

Utility Foam Index Results



Superior Ash Compatibility of FLUEPAC® Products

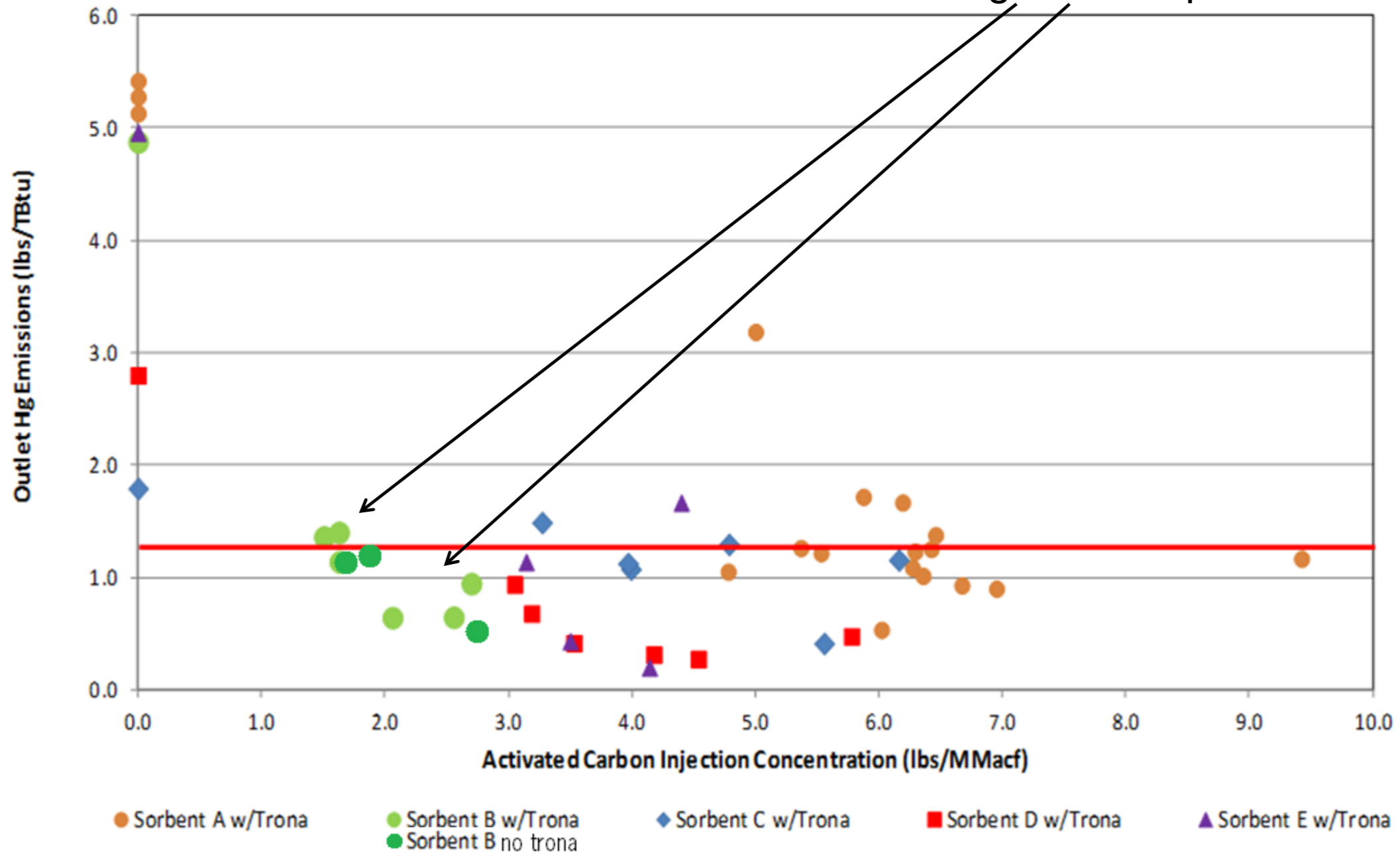
Independent Fly Ash Broker Foam Index Testing of Class F Fly Ash Mixed with 2 wt. % PAC



DSI Compatibility

FLUEPAC® DSI Compatibility

Fluepac ST with trona rates of 500 – 6,000 lbs/hr shows nearly no impact of trona on Hg removal performance



Summary of PAC Advances

Sulfur Tolerance

- Highly resistant to the negative impact of high levels of SO₃ in flue gas streams

Low Impact Carbons for Fly Ash Preservation

- Raw material selection leads to an inherently concrete-friendly carbon
- Less carbon in fly ash → More concrete friendly → **Preservation of fly ash sales**

DSI Compatibility

- Resistant to the impact that dry sorbents will have on carbon injection rates

Questions?

Thank you for your time.