



 ALBEMARLE® | Mercury Control

Alternative Method of Hg and THC Control Using Existing Cement Kiln Particulate Control Equipment

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February 9, 2010**





Portland Cement Kiln MACT

- Hg – 55 lb/MM tons of clinker
- THC – 24 ppmv as propane
- HCl – 3 ppmv
- PM – 0.04 lb/ton of clinker
- Dioxin/Furans – 0.2 ng/dscm



Cement Kiln Mercury Control



Options for Hg Control

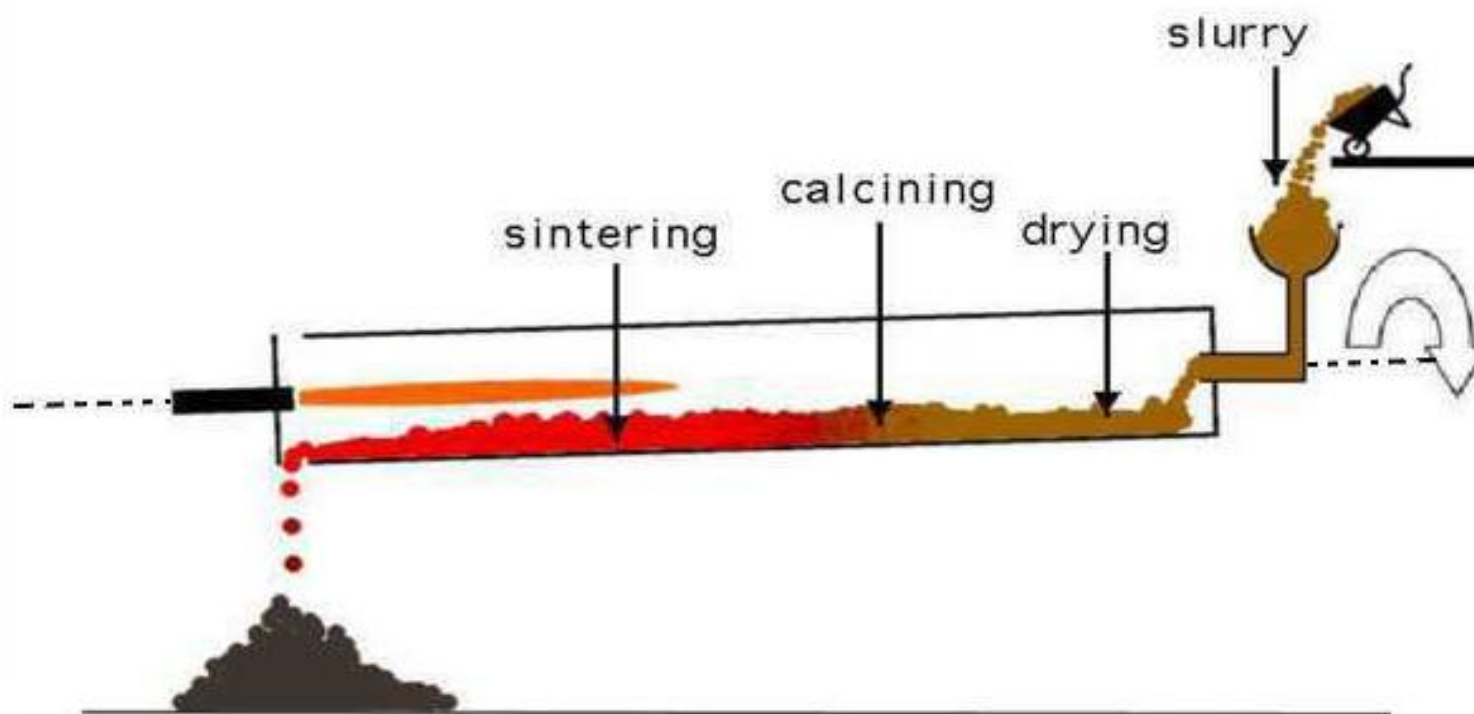
1. Shutdown
2. Change raw materials and/or fuels
3. Add a polishing baghouse and sorbent injection equipment – works but costly
4. Add only a sorbent injection system and inject C-PAC a thermally stable, Concrete-Friendly™ mercury and THC sorbent



Long Kilns – Once Through



Long Kilns



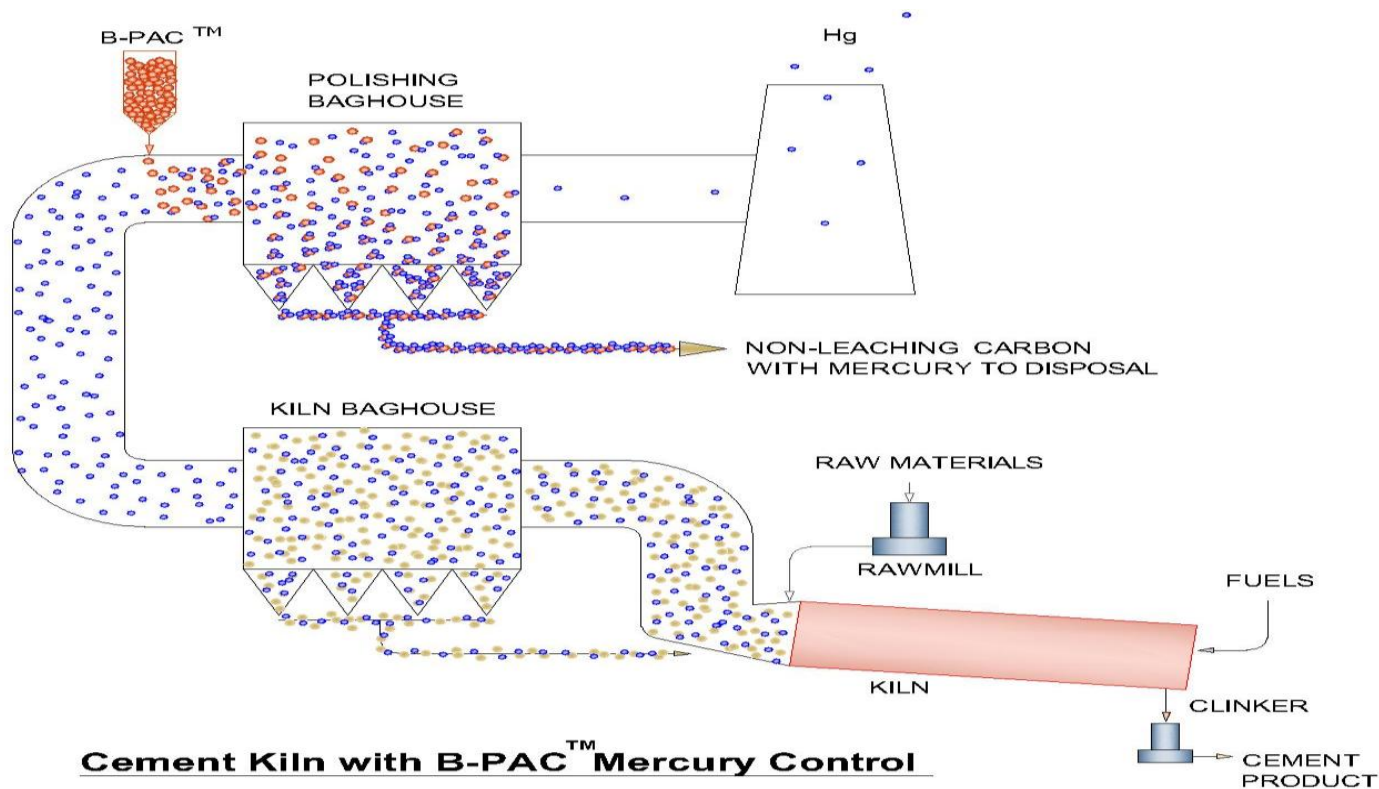


Polishing Baghouse Method

- Requires a large capital expenditure (~\$20 million)
- There is a large operating cost increase due to the operation of new fans and the cost of sorbent
- Long time for design, procurement and installation
- Potential for sorbent smoldering due to self heating so a thermally stable sorbent is necessary



Hg Control with Polishing Baghouse



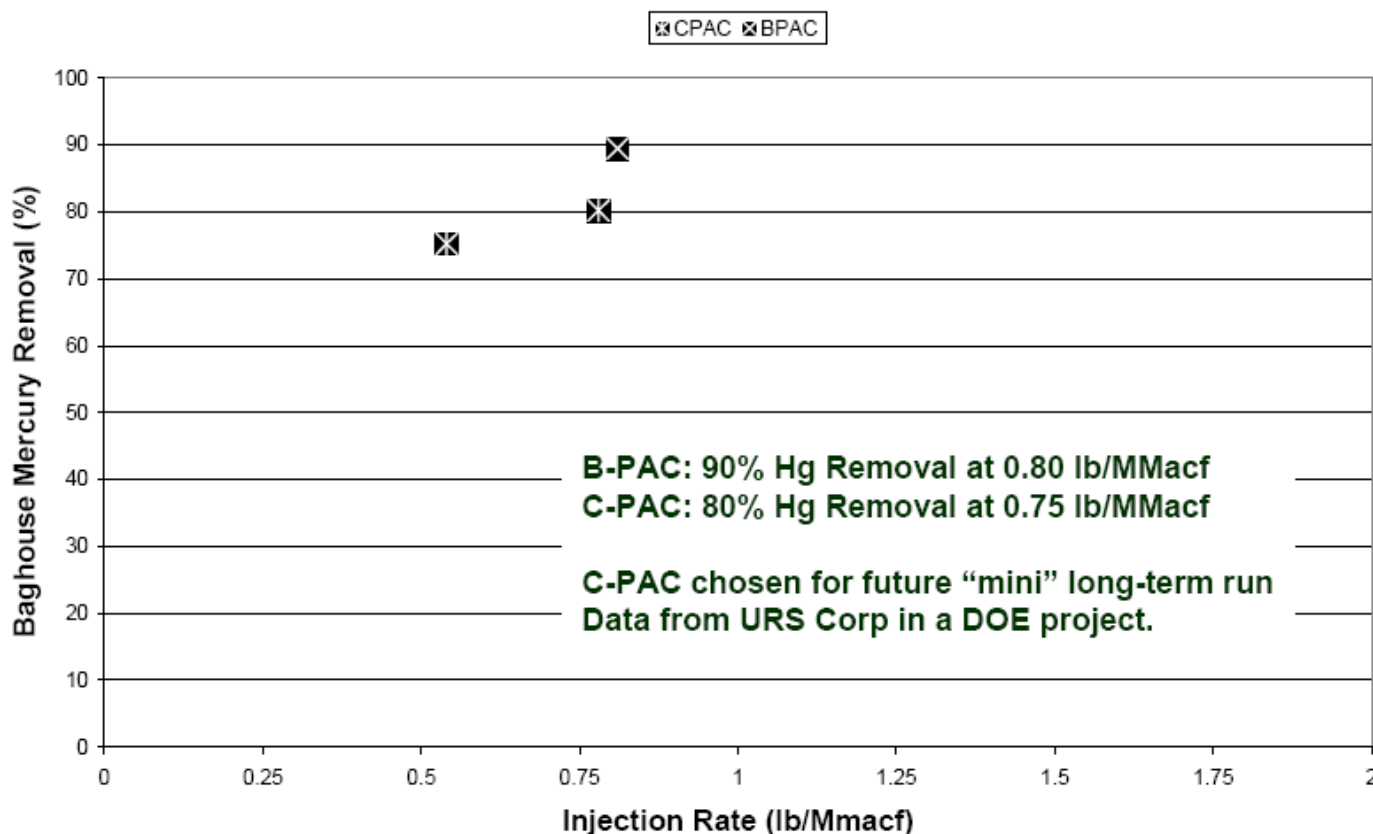
Description of Method

1. Installation of a polishing baghouse
2. Installation of equipment for handling and injecting of B-PAC for mercury control
3. Injection of B-PAC into polishing baghouse filter to capture mercury vapor
4. Disposal of B-PAC with chemically bonded mercury – mercury will not leach from B-PAC after use



Hg Capture in a Polishing Baghouse

Summary of Sorbent Mercury Removal Performance Across
Unit 3 Baghouse at Harrington Station

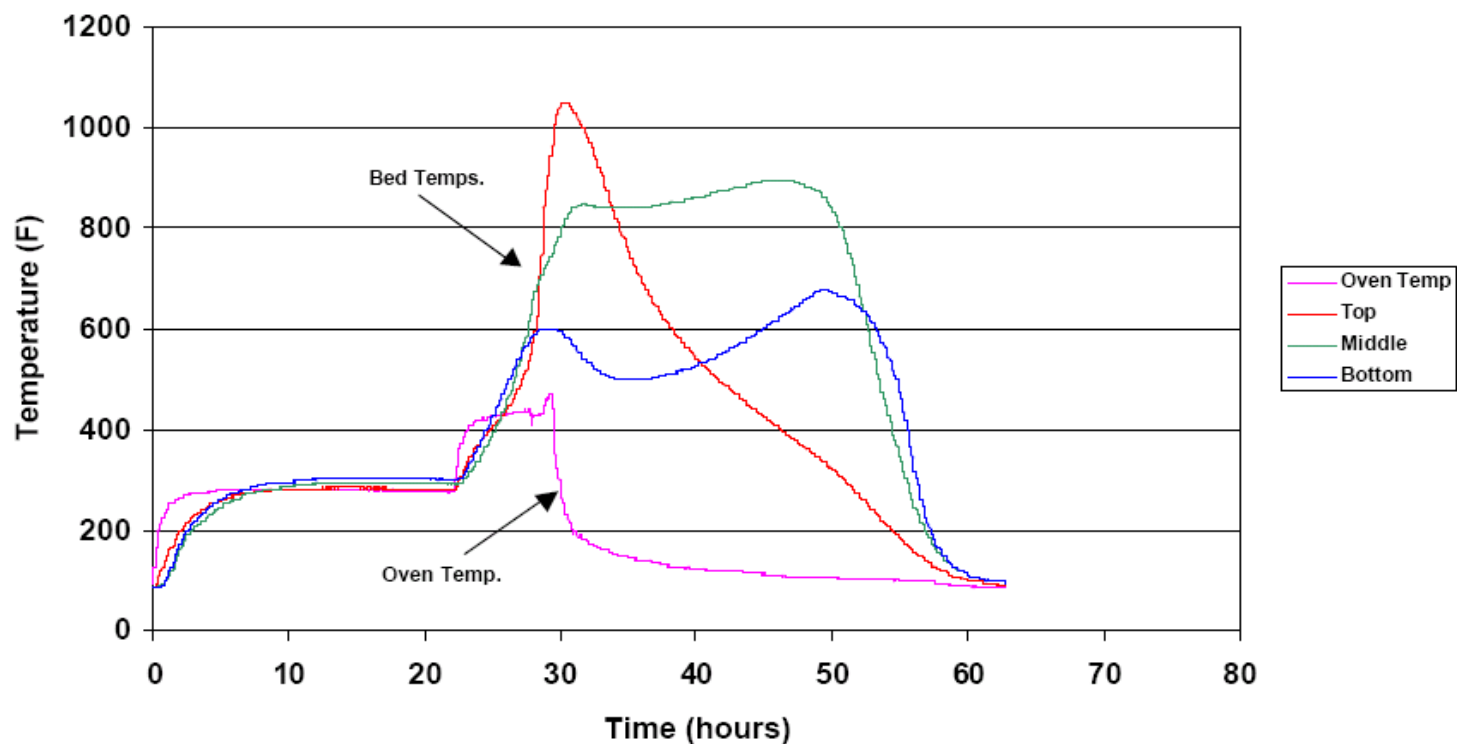


2008 Mega Symposium



Sorbent Self Heating

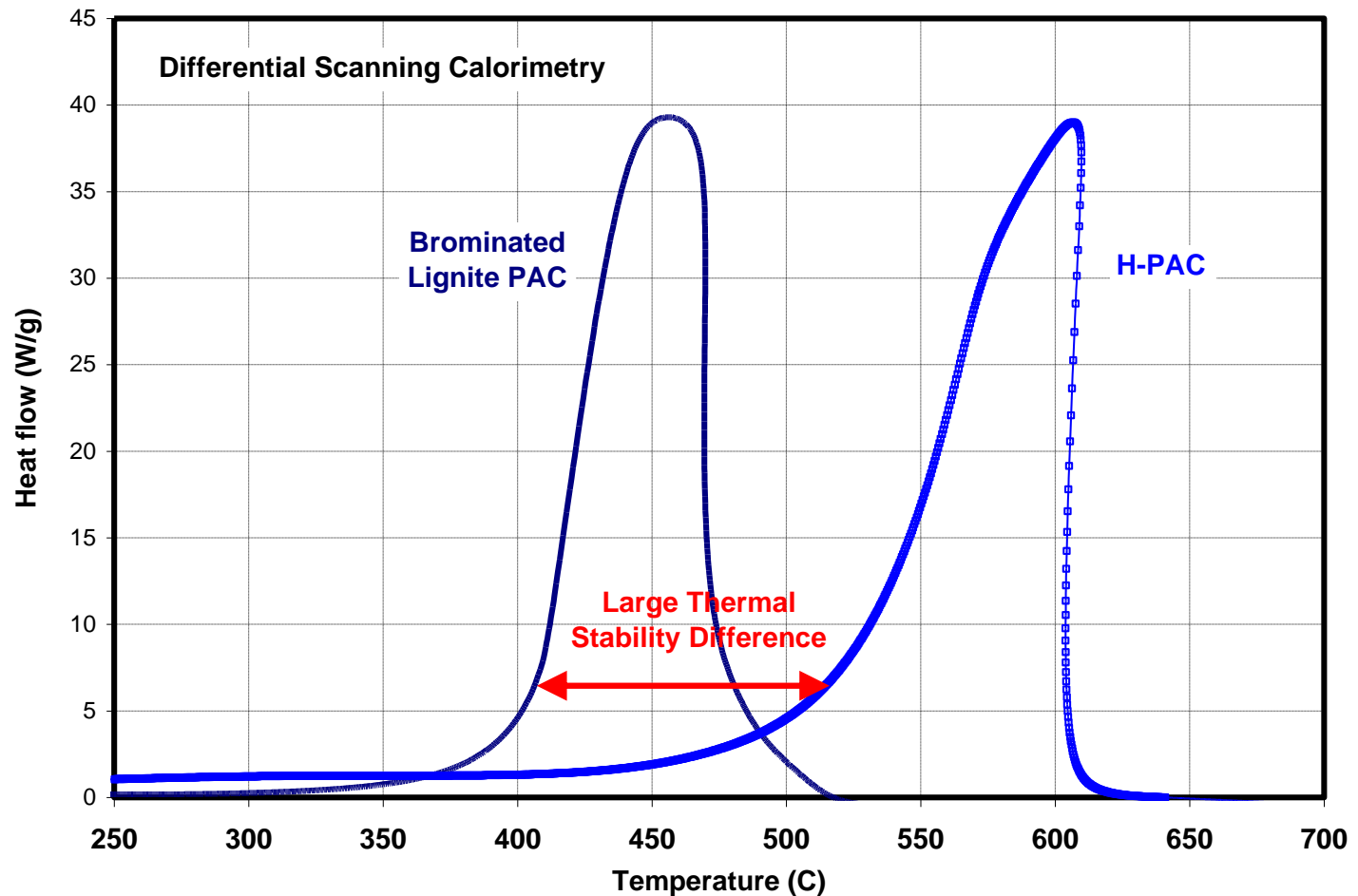
Frank-Kamenetskii Test - 6" Cube
1500 g DARCO Hg/Ash, 1.5 lb/MMacf
LOI 26.5%



Bustard, J., 2006 Mega Symposium



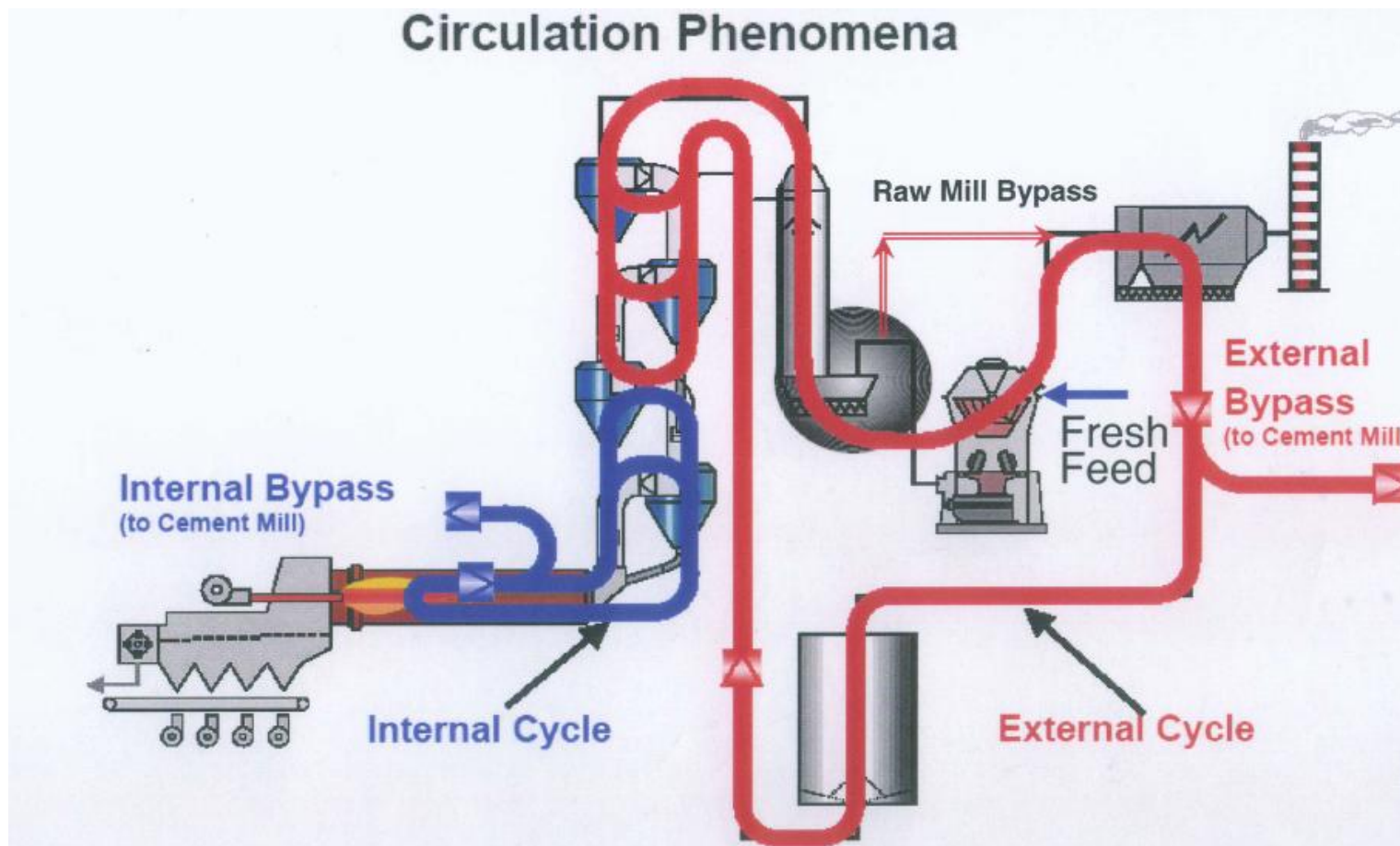
High Temperature Resistance

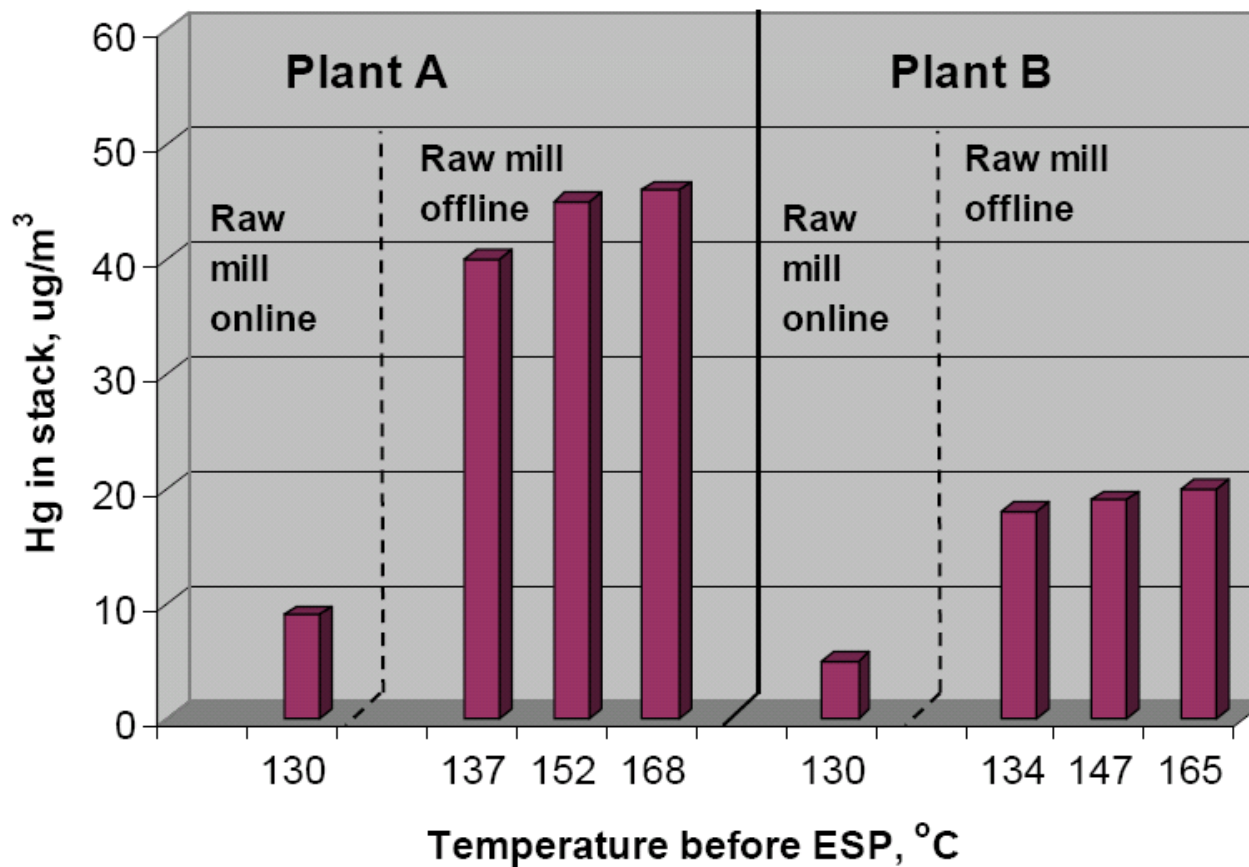




Dry Kilns – Dust Recycling

In-Process Mercury Control



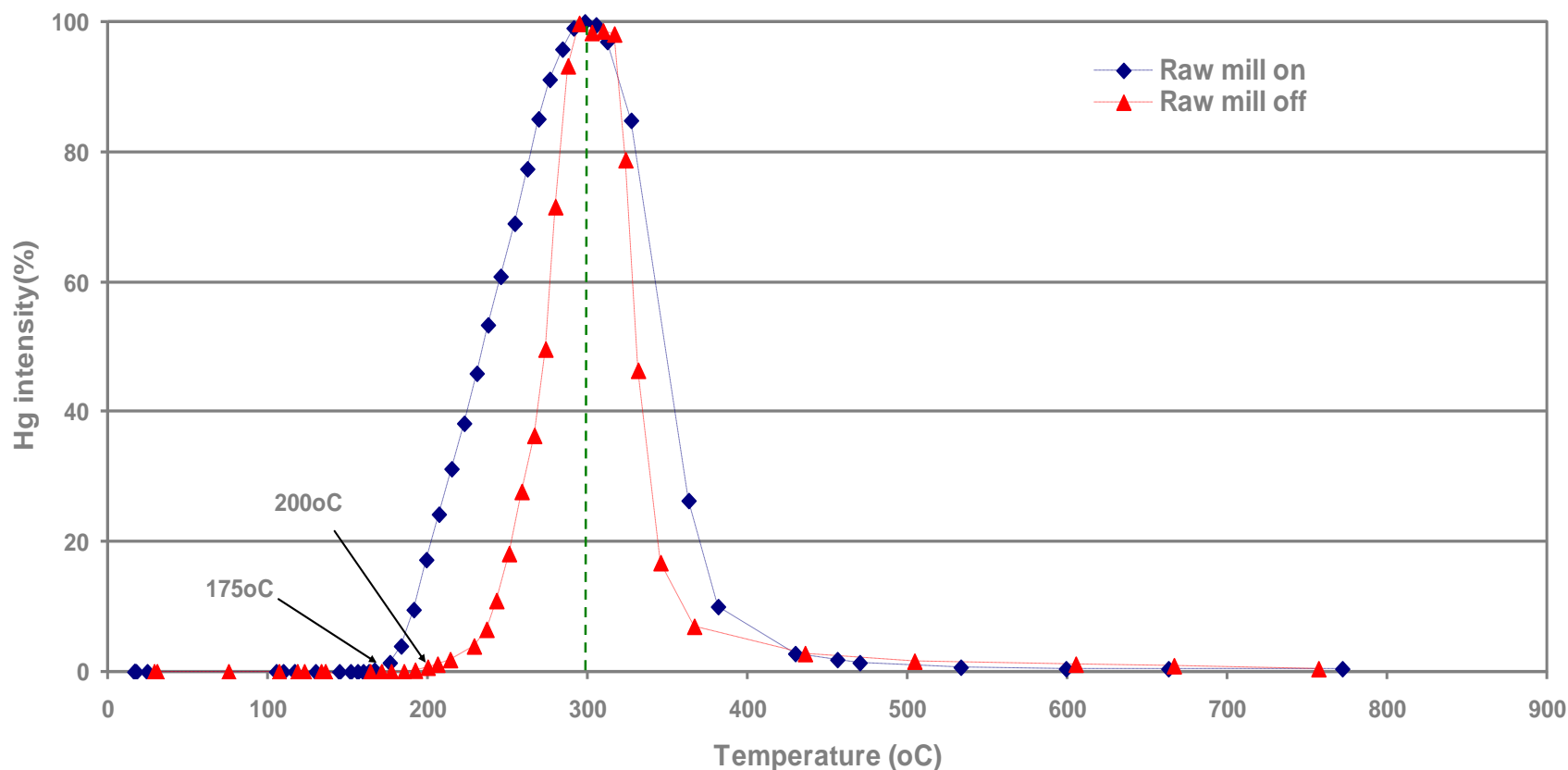


Shafer and Hoenig 2002



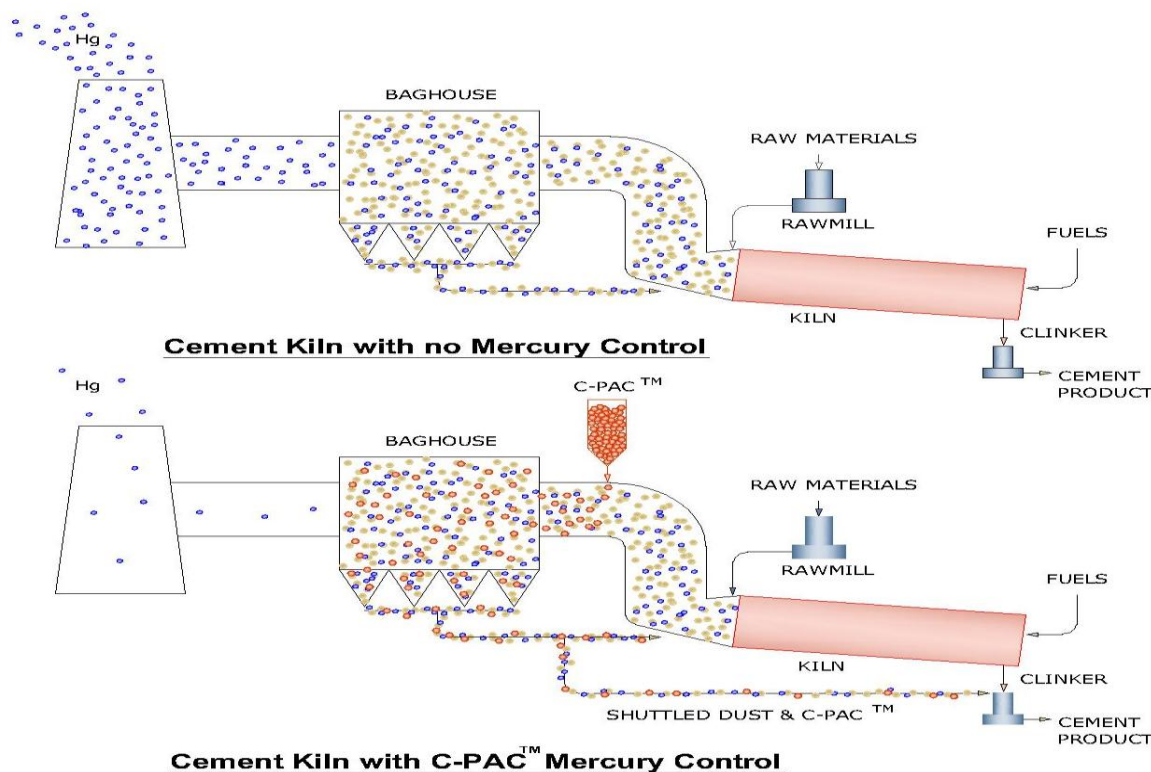
Cement Kiln Dust as a Hg Sorbent

Thermal decomposition of Hg in CKD dust from Union Bridge (in N₂)





Hg Control using Albemarle's Method



Description of Method

1. Installation of reaction control equipment for injection of C-PAC™ into kiln gas
2. Injection of C-PAC™ into kiln gas before baghouse to capture mercury vapor
3. Shuttling of baghouse dust to finish mill to remove captured mercury from plant



In-Process Mercury Control

- Requires only a sorbent injection system (<\$750,000)
- Sorbent is the main additional operating cost
- Short timeframe for equipment design, procurement and installation
- Requires a temperature insensitive, concrete-friendly mercury sorbent



M-PACT Sorbent Injection System



- For use in applications requiring an injection rate of less than 200 pounds of sorbent per hour.
- Less capital cost and less installation cost
- Up to 5000 pound sorbent storage capacity and can be fed from a tanker used for sorbent storage



Silo Injection Systems

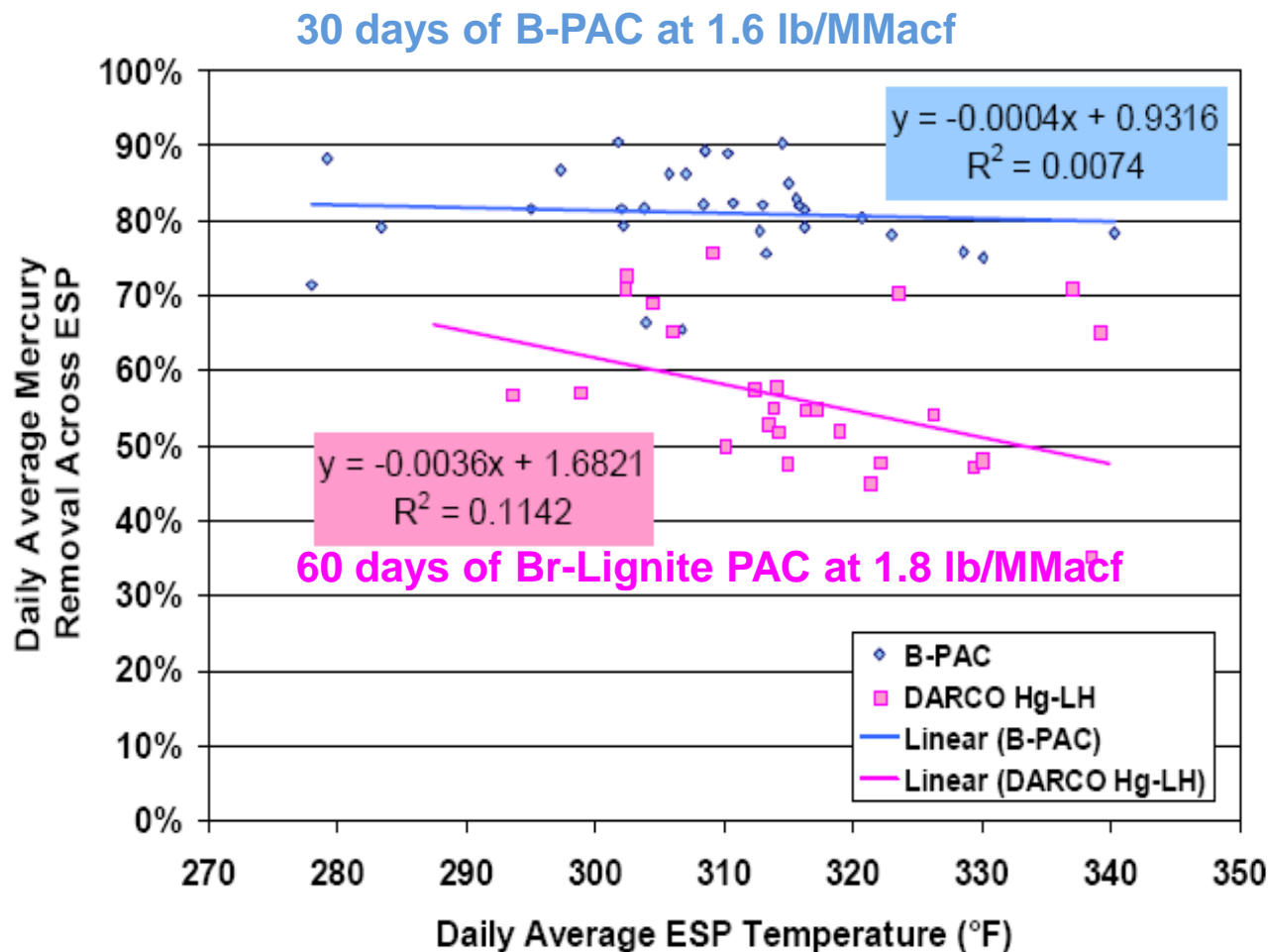




Temperature Insensitive Sorbent



Hg



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



Concrete-Friendly Sorbent



Answer: Concrete-Friendly™ C-PAC™

- Rather than process the entire gas stream (Toxecon®), or the entire fly ash load (post-processing), just concentrate on the offending 1% to 3% C: the sorbent
- Process the PAC sorbent so that it does not interfere with the AEAs -- while retaining its Hg performance
- C-PAC is 100% Activated Carbon and Bromine, no added chemicals that would effect concrete properties



Problems with the “Foam Index” Metric

- Lack of repeatability
- Operator discretion
- Different & variable natural reagents
- Foam index is specific to the AEA
- Varying glassware & “drop” sizes
- Non-standardized procedures
- Dynamic, non-equilibrium test



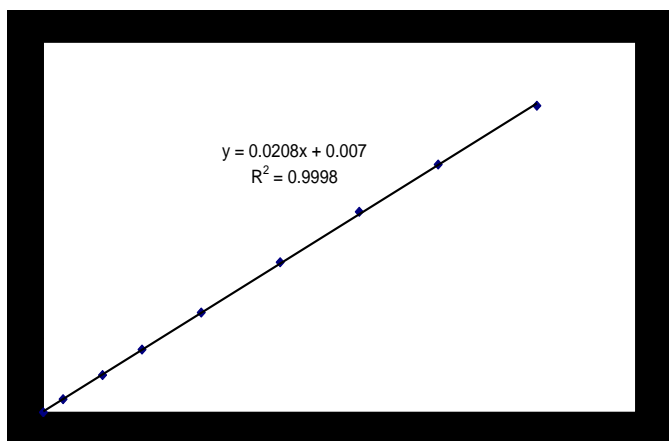


Standardized “Acid Blue 80 Index” Instead



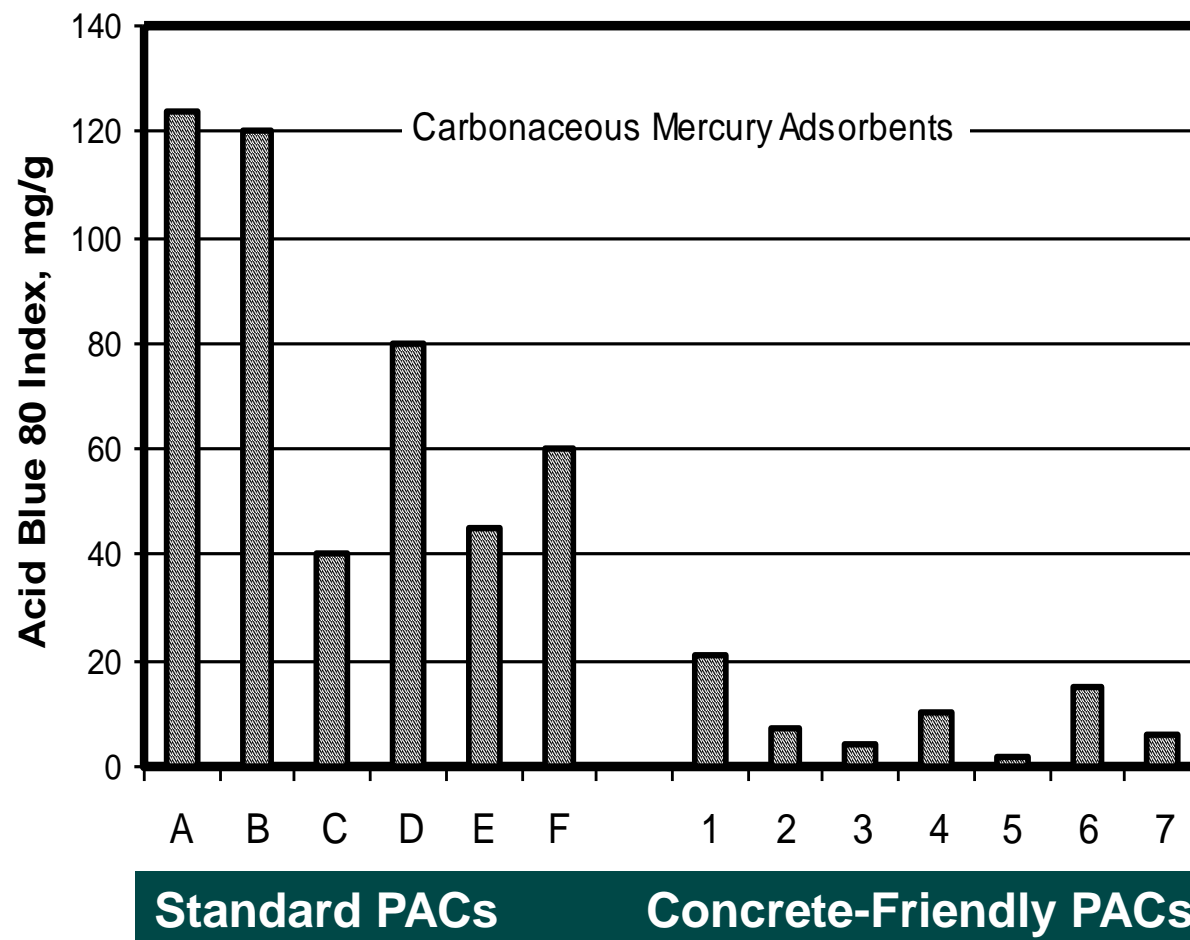
Similar to: ASTM D 3860-98 Standard Practice for Determination of Adsorptive Capacity of Activated Carbon by Aqueous Phase Isotherm Technique

1. Pre-dry sample at 150°C for 3 hours.
2. Add different dosages of dried PAC to 50ml of 100 mg/l AB80 solution and well stir.
3. Once an equilibrium, filter the carbon from the AB80.
4. Determine the concentration of the filtrate e.g. by a Perkin Elmer Lambda EZ201 Spectrophotometer.
5. Calculate the AB80 removed by the PAC from the change in the solution before & after PAC contact.
6. Plot the AB80 adsorption of the dosage carbon with the equilibrium concentration of AB80 solution.
7. Calculate the adsorptive capacity from a Freundlich isotherm plot at the original AB80 concentration, which is defined as Acid Blue Index (ABI).



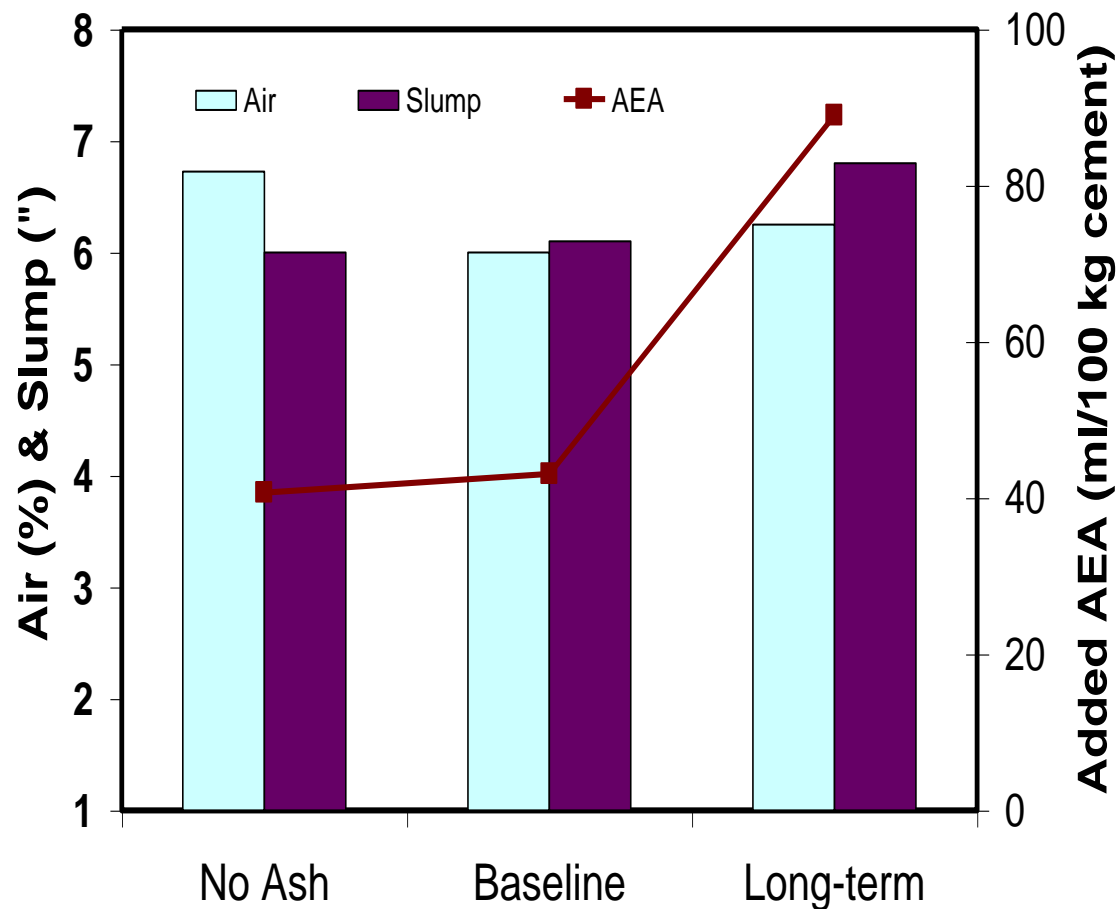


Low Sorbent ABIs Mean Concrete-Friendly





C-PAC in Concrete

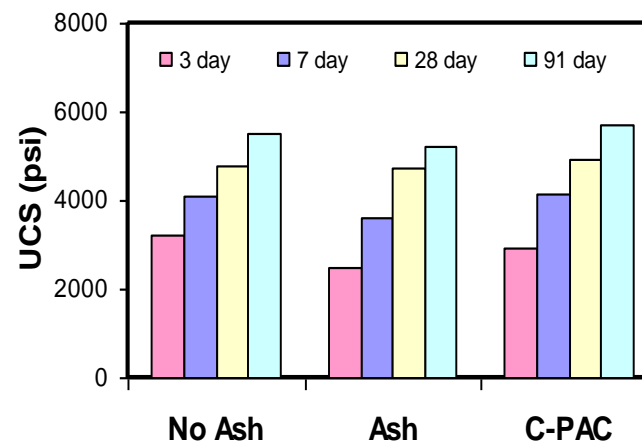




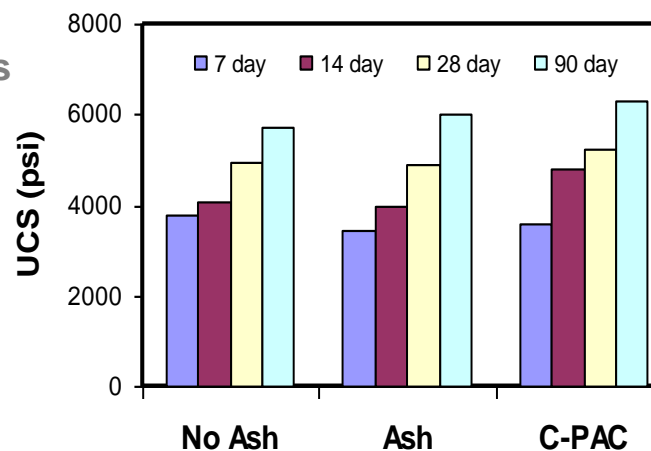
Still High Compressive Strength



Headwaters
Data



Sorbent
Technologies
Data



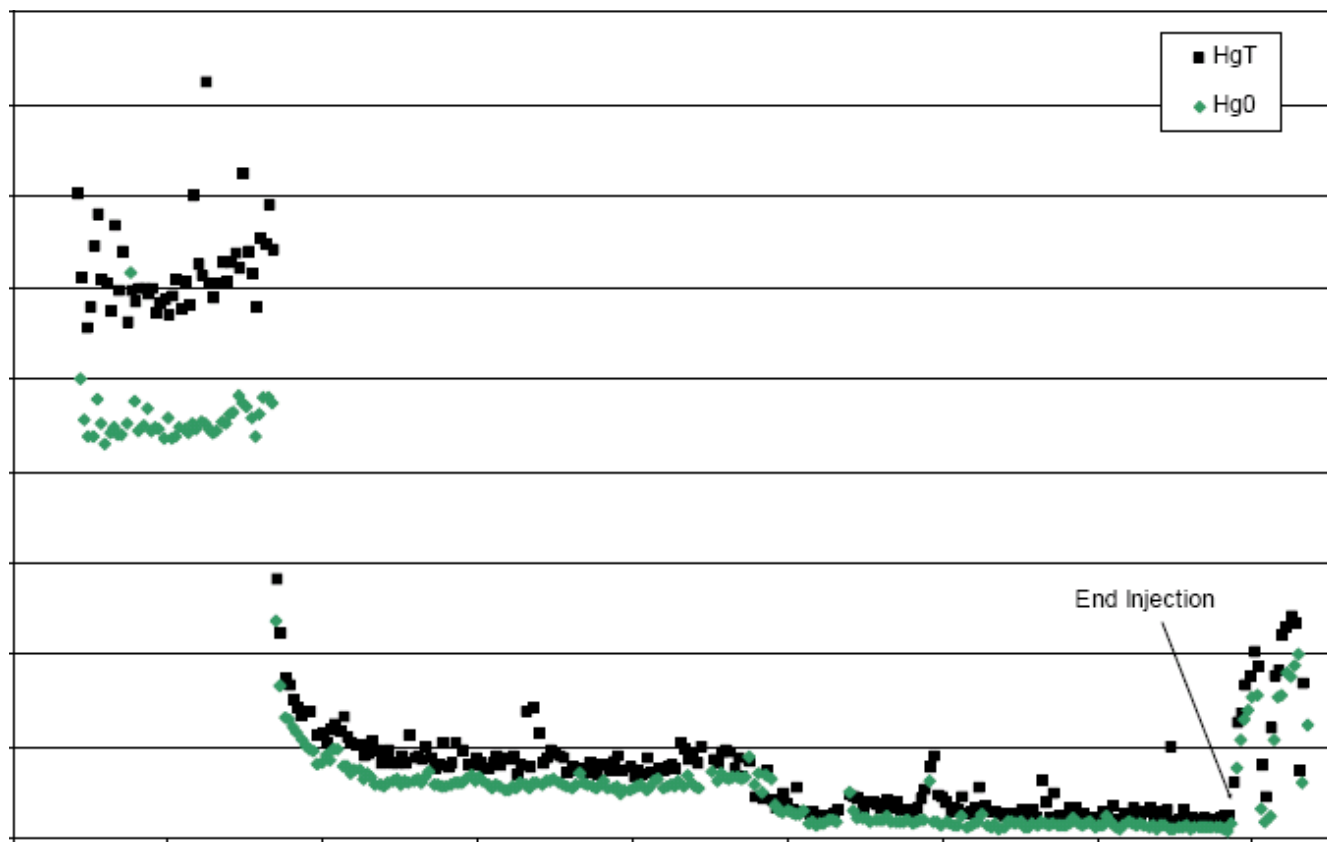


In-Process Control Process

- Utilize the existing baghouse
- Add only a sorbent injection system (low capital cost)
- Use C-PAC™ a concrete-friendly™ sorbent
- Inject only at selected times
- Direct CKD collected during injection to cement mill rather than recycle to the cement kiln



Expected Results at Low Injection Rates





Patent pending on carbon-based concrete-friendly™ mercury sorbents

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 May 2008 (29.05.2008)

PCT

(10) International Publication Number
WO 2008/064360 A2

(51) International Patent Classification:
A61M 5/155 (2006.01)

(21) International Application Number:
PCT/US2007/085474

(22) International Filing Date:
23 November 2007 (23.11.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/860,563 22 November 2006 (22.11.2006) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AI, AM, AT, AU, AZ, BA, BB, BG, BI, BR, BW, BY, BZ, CA, CI, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

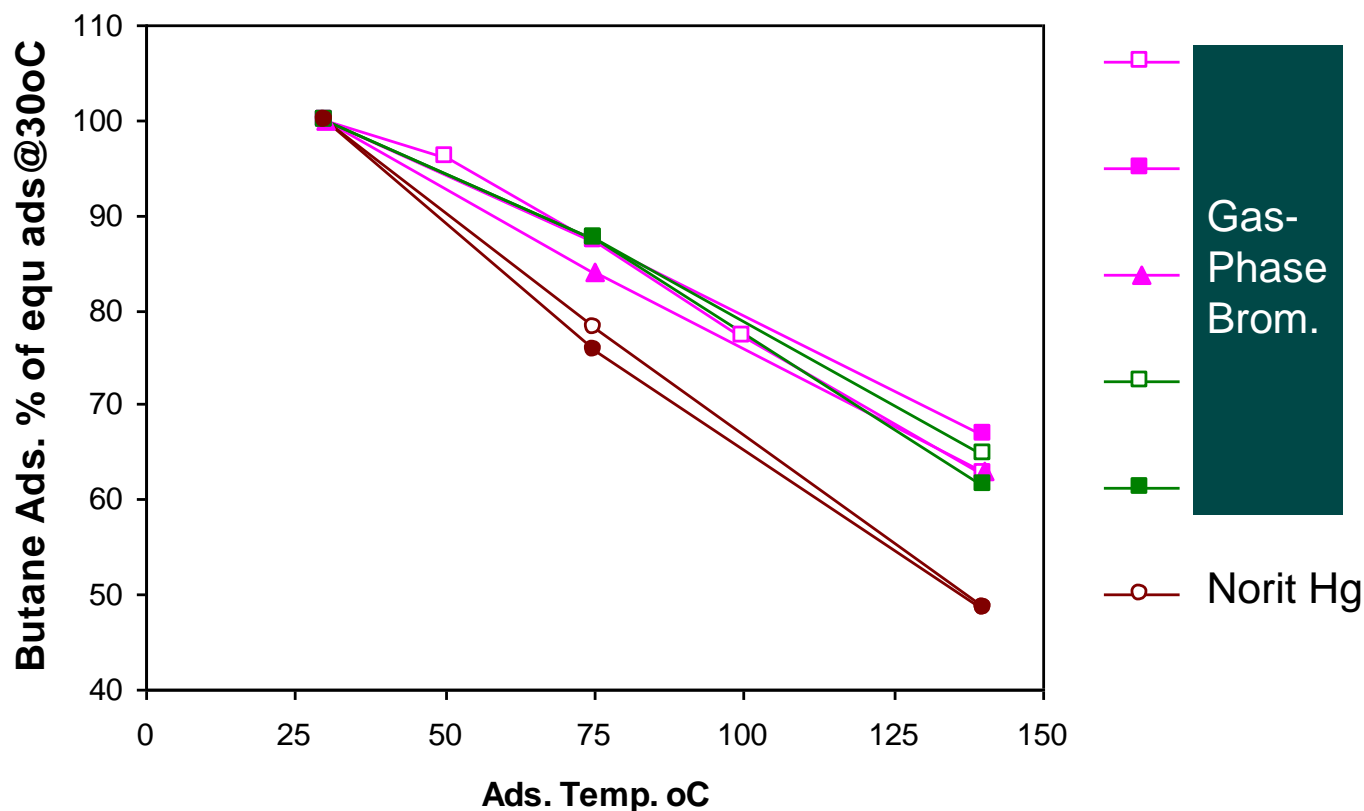


THC Capture



Organic HAPs Control

Butane Ads. of Various Carbons with Temp.





ACI Appeared to Significantly Lower PAHs

- PAHs were measurable at only one of nine boilers using Activated Carbon Injection

	# Conventional Boilers with PAH Measurements	Boilers Below Detection Limit	Mean Log-Mean of 7 PAH Detect.Limits of Those BDL	Boilers Above Detection Limit	Percent Above	Log-Mean of B[a]P & B[a]A (lb/MTBtu)
No ACI	52	32	125 E-09 lb/MMBtu	20	38%	10.0 / 16.0
ACI	10	9	137 E-09 lb/MMBtu	1	10%	- / 0.7

- Even at that one, the PAHs were very, very low
(And the average detection limits with non-ACI units was identical)
This data is not inconsistent with 90+% PAH reductions with ACI
- So, fortunately, an inexpensive, easily-retrofitable co-benefit solution appears at hand



High ACI PAH Performance is Not Unexpected

- There are commercial PAC products to specifically remove PAHs from oils
- AC has been demonstrated to reduce PAHs from water, contaminated soil, even MWC flue gases
- AC adsorbs larger hydrocarbons well, like many-ringed PAHs; AC does not adsorb small organics well



ACI system at a power plant



Questions?

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