EERC Technology… Putting Research into Practice

Large-Scale Mercury Control Technology Testing for Lignite-Fired Utilities – Oxidation Systems for Wet FGD

Mega Symposium 2006

Baltimore Marriott Waterfront

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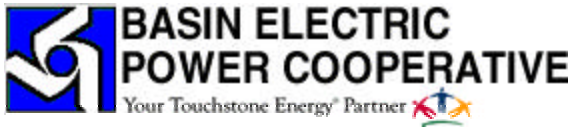
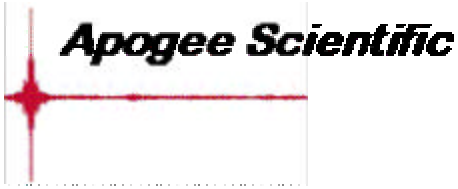
August 28–31, 2006

Partnership Team

North Dakota Industrial Commission





Westmoreland Coal

Introduction

- Two host sites for field testing
  - TXU Monticello Steam Electric Station Unit 3 near Mt. Pleasant, Texas
  - Minnkota Power Cooperative Milton R. Young (MRY) Station Unit 2 near Center, North Dakota

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Goal

- Evaluate cost-effective approaches for capturing the Hg in lignitic combustion flue gases using a cold-side electrostatic precipitator (ESP) and/or wet flue gas desulfurization (FGD) system.
- ESP–wet FGD Hg removal efficiency of ≥55% on a consistent basis.

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Objectives

- Evaluate potential Hg control technologies
  - Hg^0 oxidation agents
  - A sorbent enhancement agent
  - Powdered activated carbon (PAC) injection
- Evaluate potential long-term balance-of-plant effects associated with chemical and PAC injections
  - Ash deposition and corrosion
  - Fly ash Hg mobility

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MRY Unit 2

- B&W Carolina-type radiant boiler
  - Cyclone-fired, balanced-draft, pump-assisted circulation boiler
  - Began commercial operation in May 1977
  - Base-loaded at 450 MW gross
  - Lignite from Center Mine
- Pollution controls
  - Cold-side ESP (specific collection area of 375 ft^2/kacfm)
  - Spray tower FGD (alkaline ash and lime)

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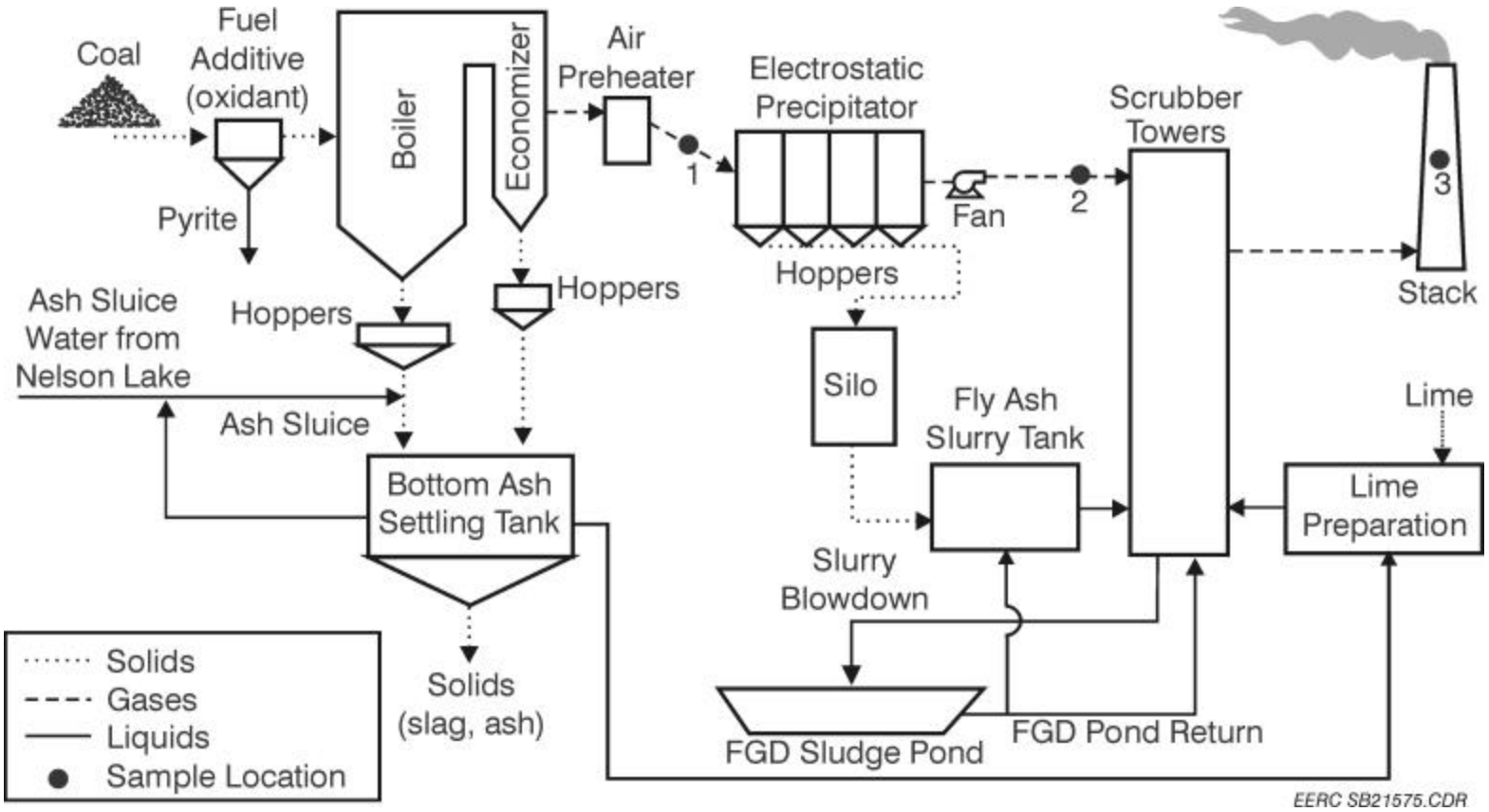
Schematic of MRY Unit 2



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Potential Mercury Control Technologies

- Hg^0 oxidizing agents
  - $CaCl_2$
  - $MgCl_2$
- Sorbent enhancement agent
  - SEA2
- PAC injection
  - NORIT Americas Inc. DARCO® Hg

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Aqueous $MgCl_2$, $CaCl_2$, and SEA2 Storage Tanks

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Pumping and Metering Skid

- 0.1–2.2 gal/min = ≤500 ppm (as-fired coal basis)

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Injection Lances

- Injected into four coal feed pipes of the twelve Unit 2 cyclones

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PAC Injection System

- Apogee Portapac metering skid, blower, connecting lines, and injection lances
- PAC injected at 16 locations into the ductwork upstream of the ESP

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Experimental

- Flue gas Hg measurements
  - ASTM International Method D6784-02 (Ontario Hydro [OH] method)
  - Continuous mercury monitoring (CMM)
    - Tekran Model 2537A atomic fluorescence-based Hg vapor analyzer combined with a PS Analytical S235C400 wet-chemistry conversion unit

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Experimental

- Hg mobility analyses of ESP captured fly ash
  - Leachability
    - Synthetic groundwater leaching procedure (SGLP)
    - Long term (30- and 60-day) leaching procedure (LTLP)
  - Thermal stability
    - Hg thermal desorption apparatus

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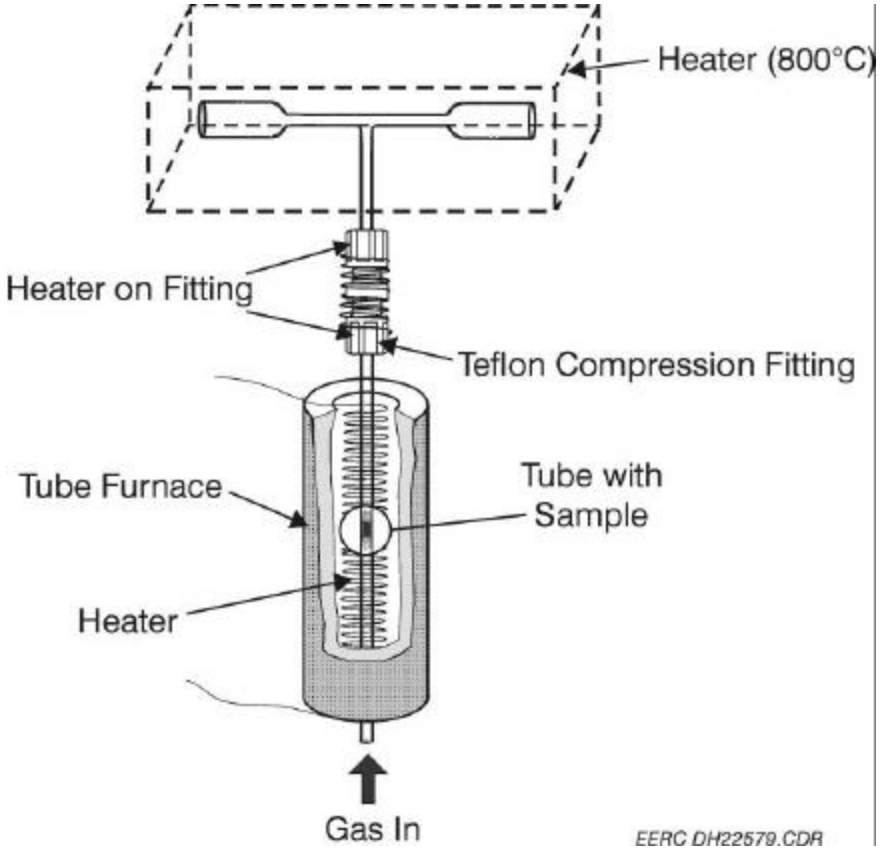
Hg Thermal Desorption Apparatus



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Deposition/Corrosion Probe Assembly

- Economizer (ECM), 460°F
- Air heater inlet (AHI), 485°F
- Air heater outlet (AHO), 270°F

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Deposition/Corrosion Coupon

- Baseline coupons exposed for 8 weeks
- Hg control technology coupons exposed for 6 weeks during chemical and PAC injections
- Coupons analyzed using SEM

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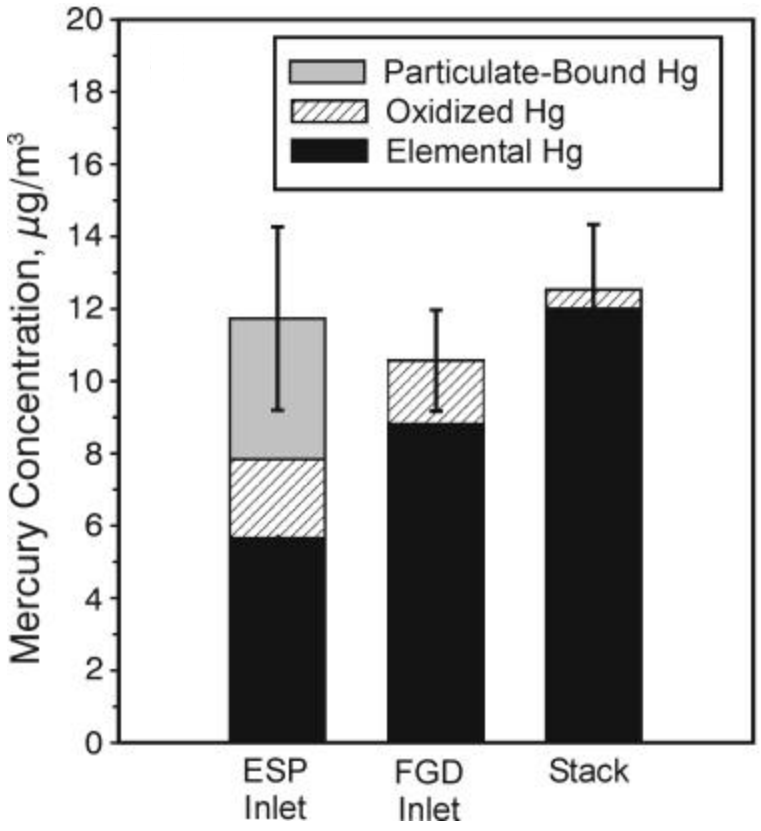
Baseline MRY Unit 2 Hg Measurements (Oct. 22–Nov. 14, 2002)



- Total Hg, FGD inlet = 10.7 ± 2.7 μg/m^3
- Total Hg, stack = 9.3 ± 2.2 μg/m^3
- Hg^0 composed 90% of total stack Hg
- Hg mass balance = 102-103%

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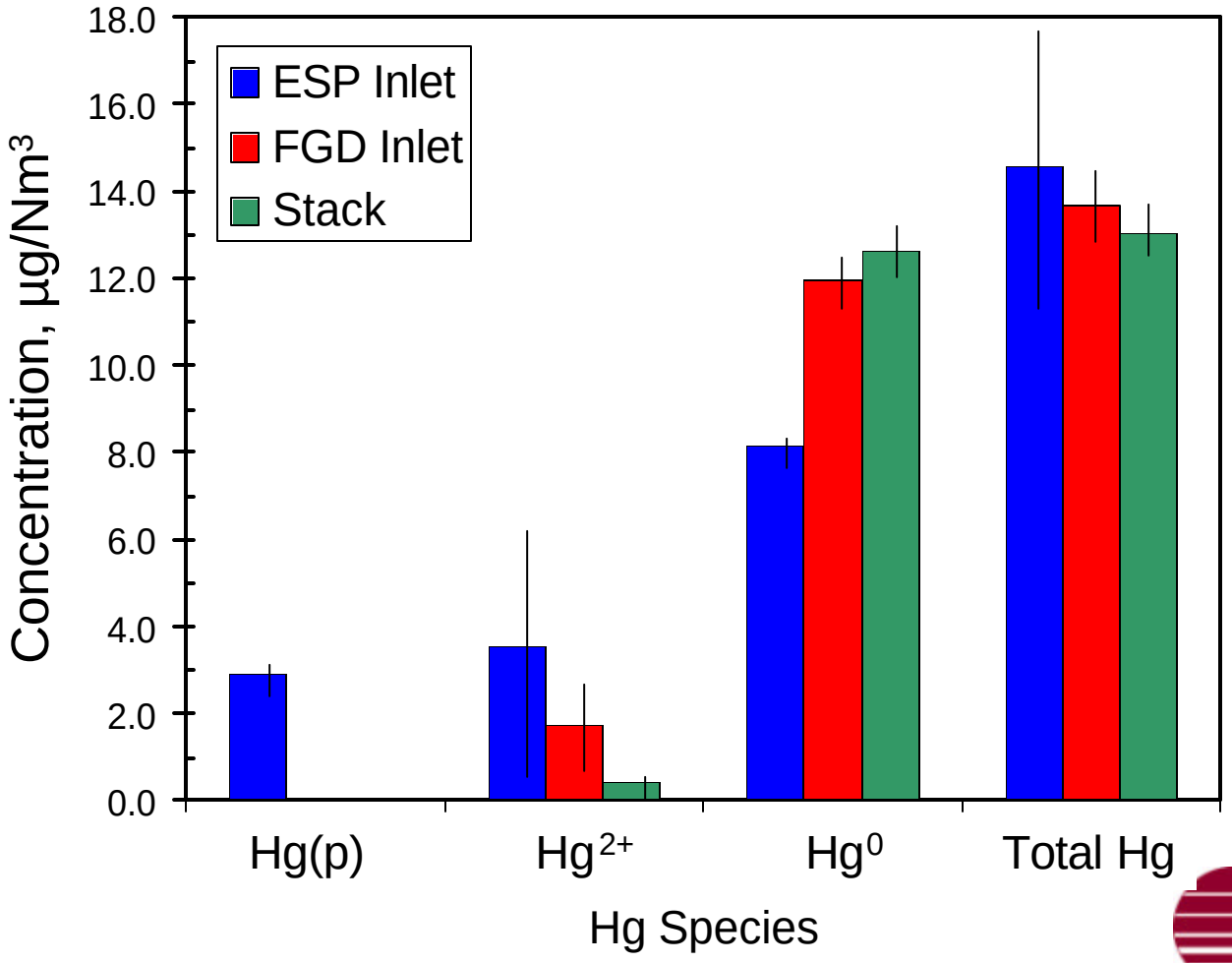
Baseline MRY Unit 2 Hg Measurements (March 16-18, 2005)



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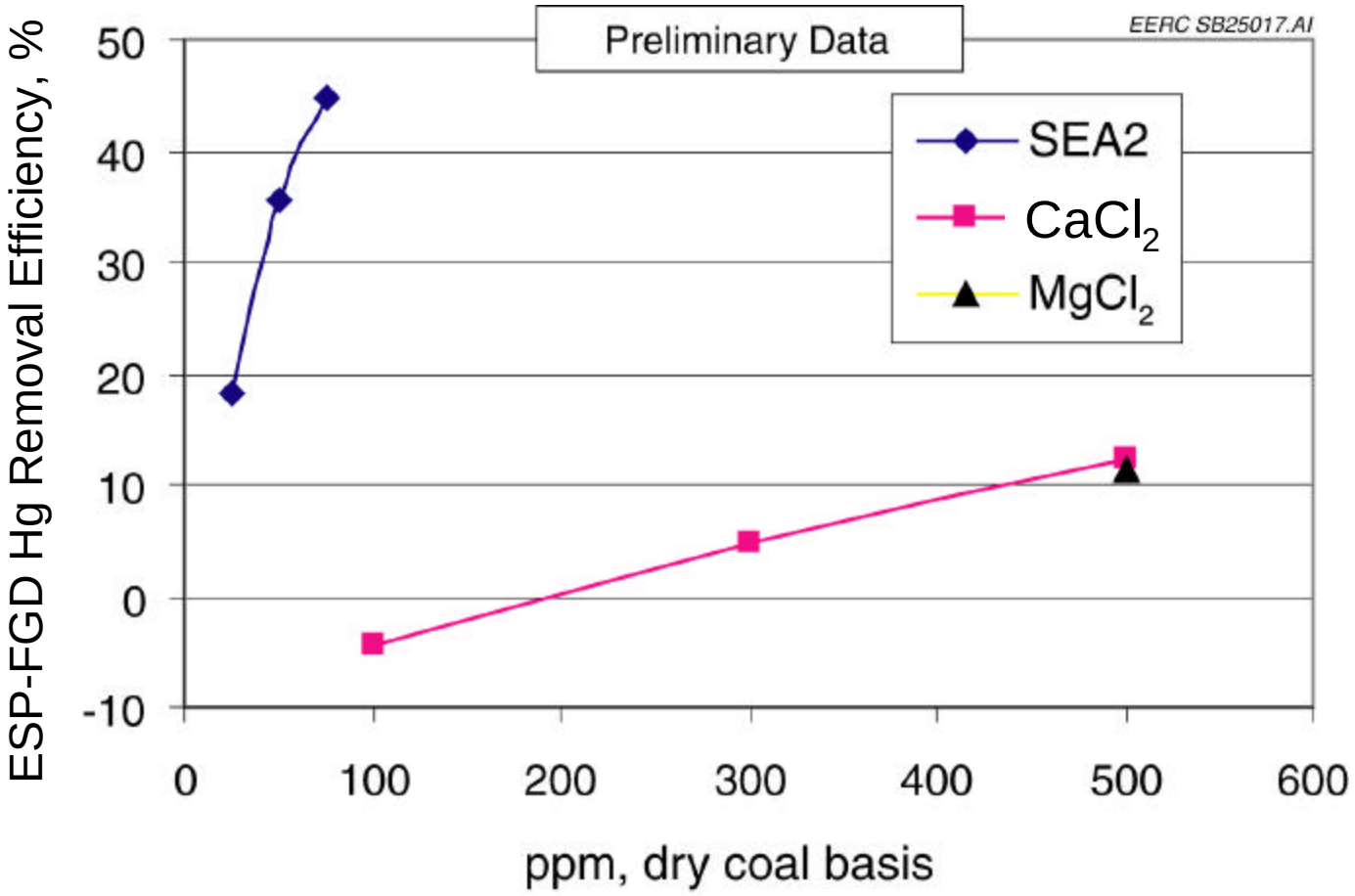
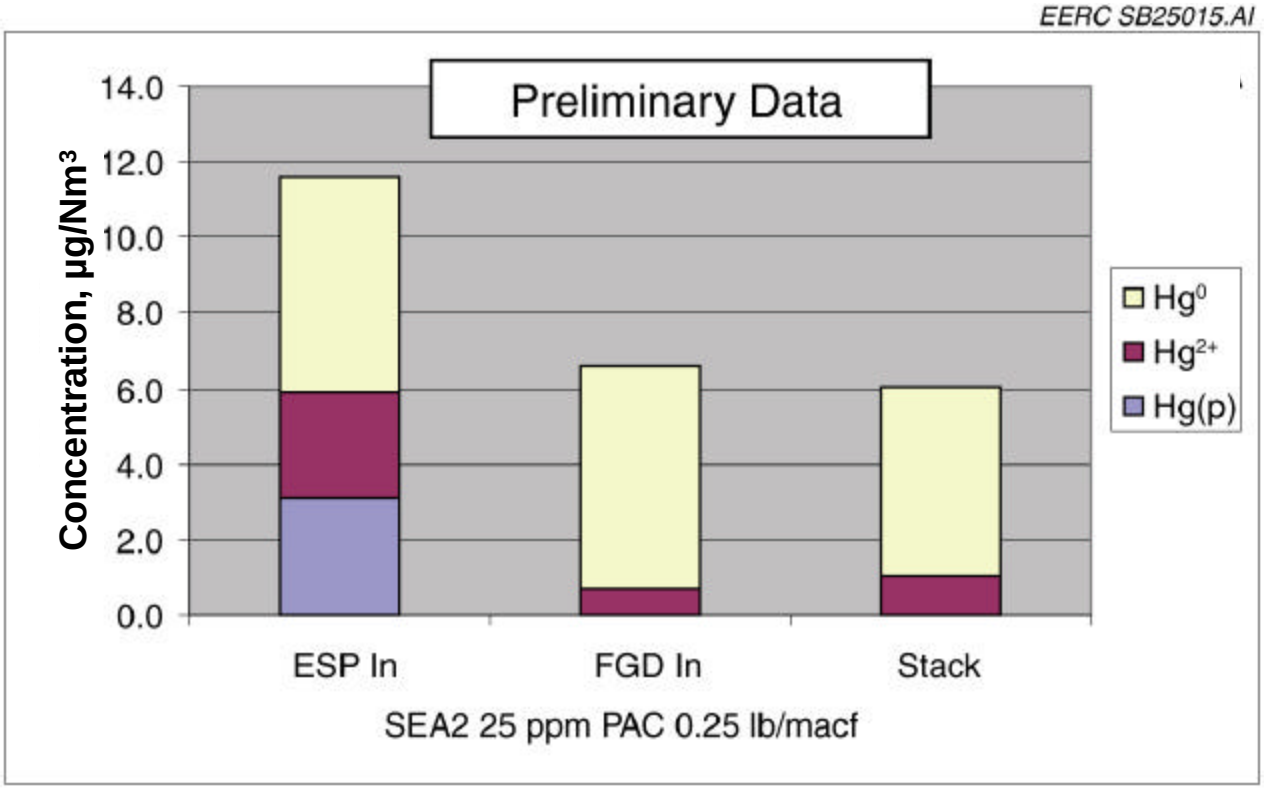
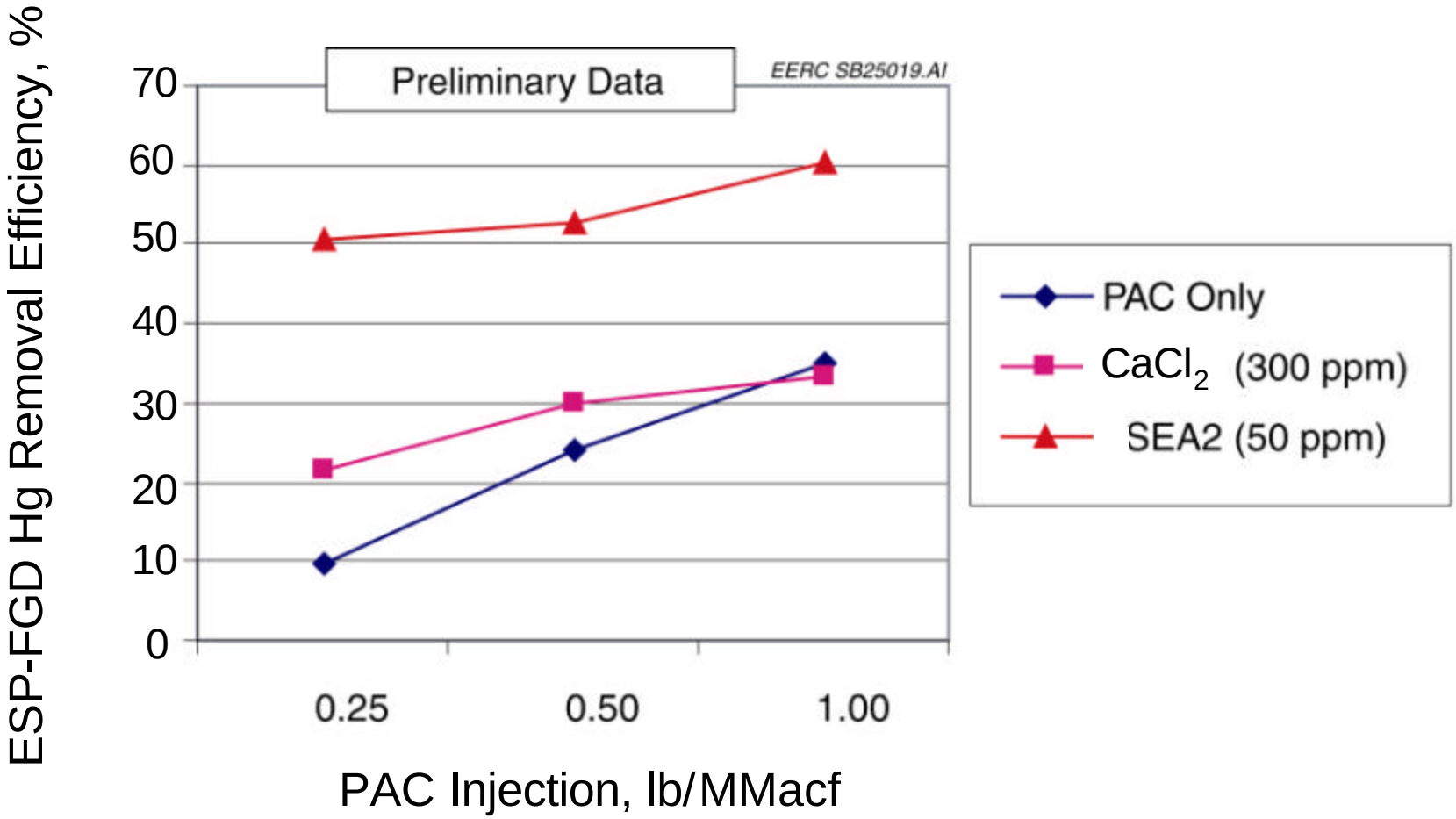
Chemical Addition Effects on Hg Capture



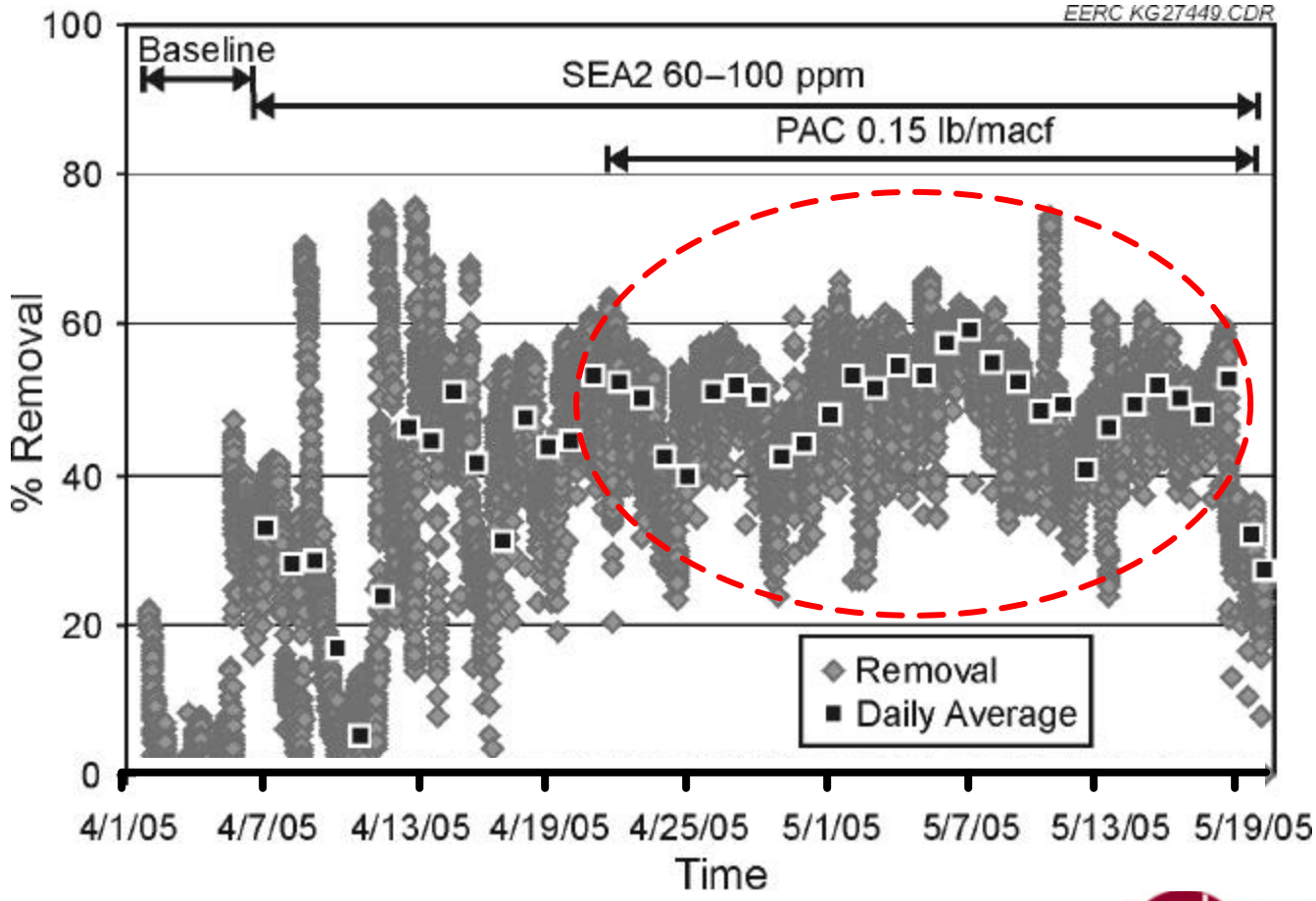
SEA2 and PAC Injection



Effects of PAC and Chemical Injections on Hg Capture



Long-Term Hg Control Test Results



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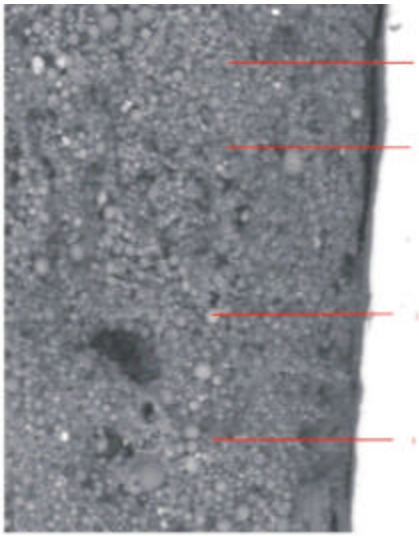
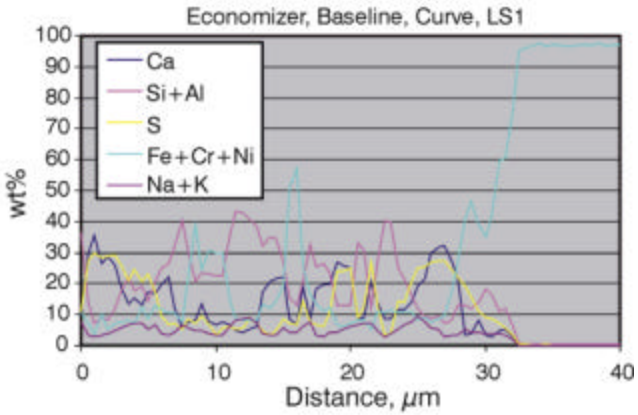
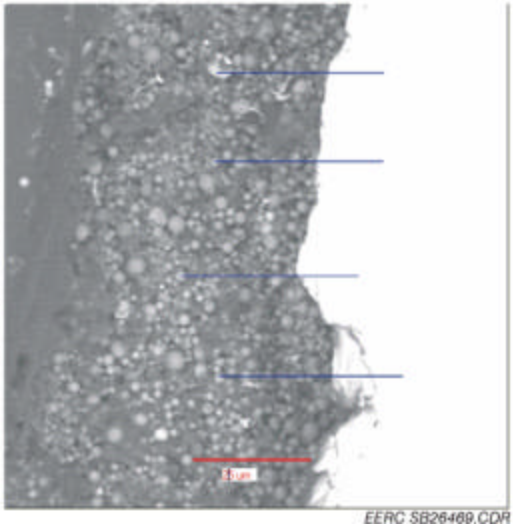
Economizer Coupons

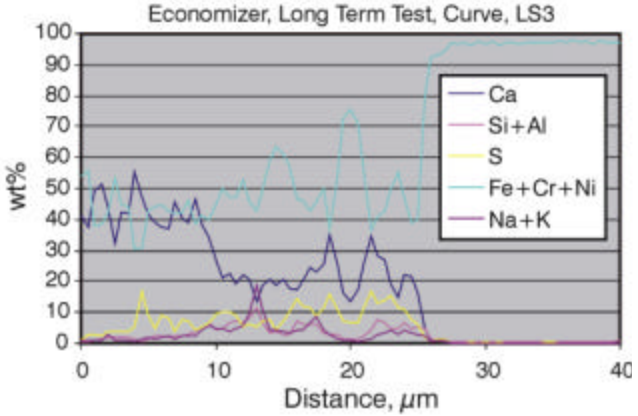
Baseline





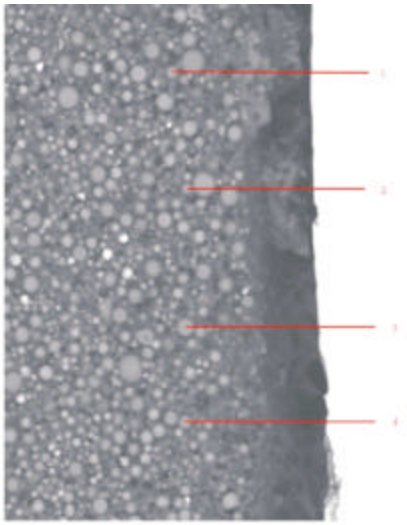
Hg-Control

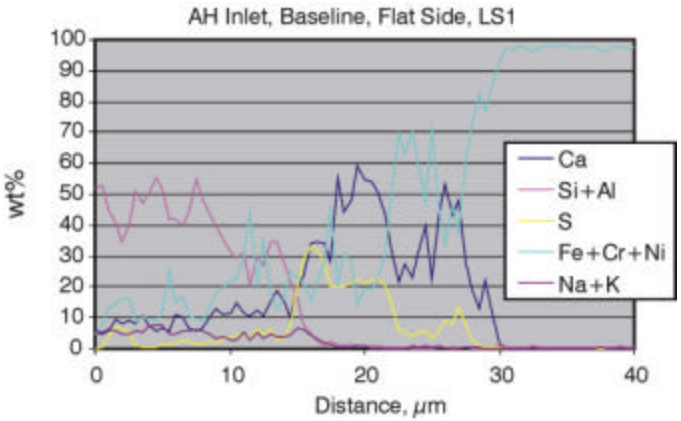




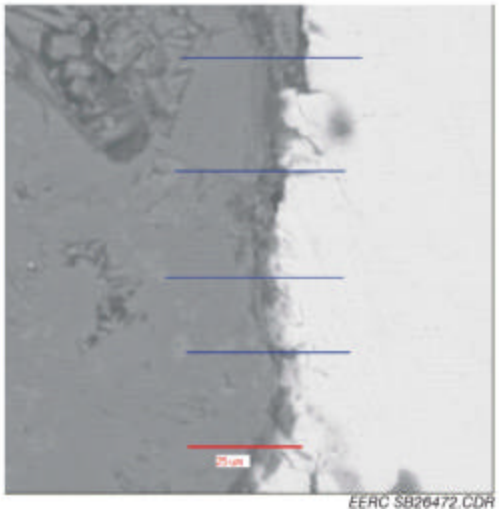
Air Heater Inlet Coupons

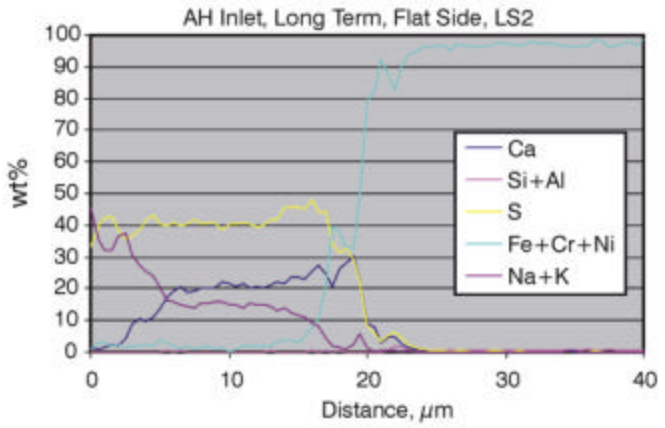
Baseline





Hg-Control





Hg Leachability from Fly Ashes

- Hg concentrations in baseline and Hg control (SEA2 and PAC) fly ash leachates from SGLP and LTLP were <0.01 µg/L.

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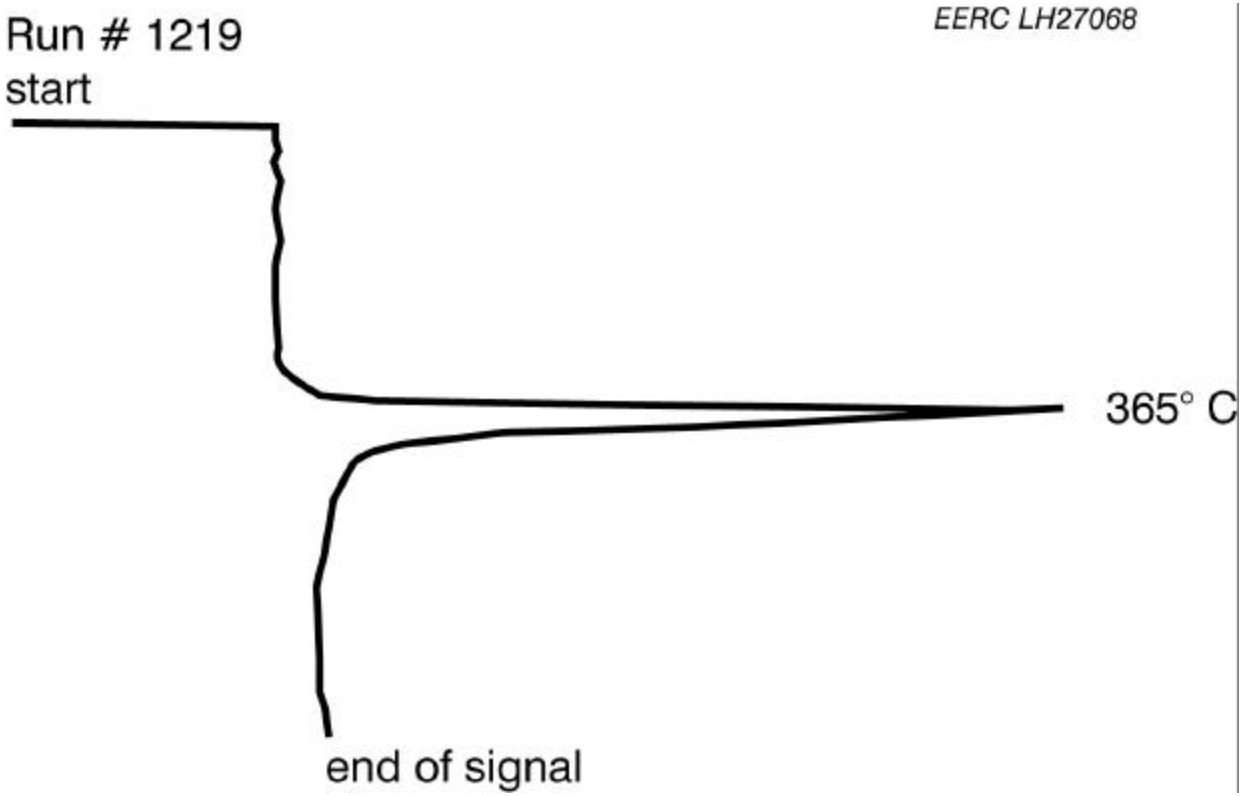
Hg Thermal Desorption from Baseline Fly Ash



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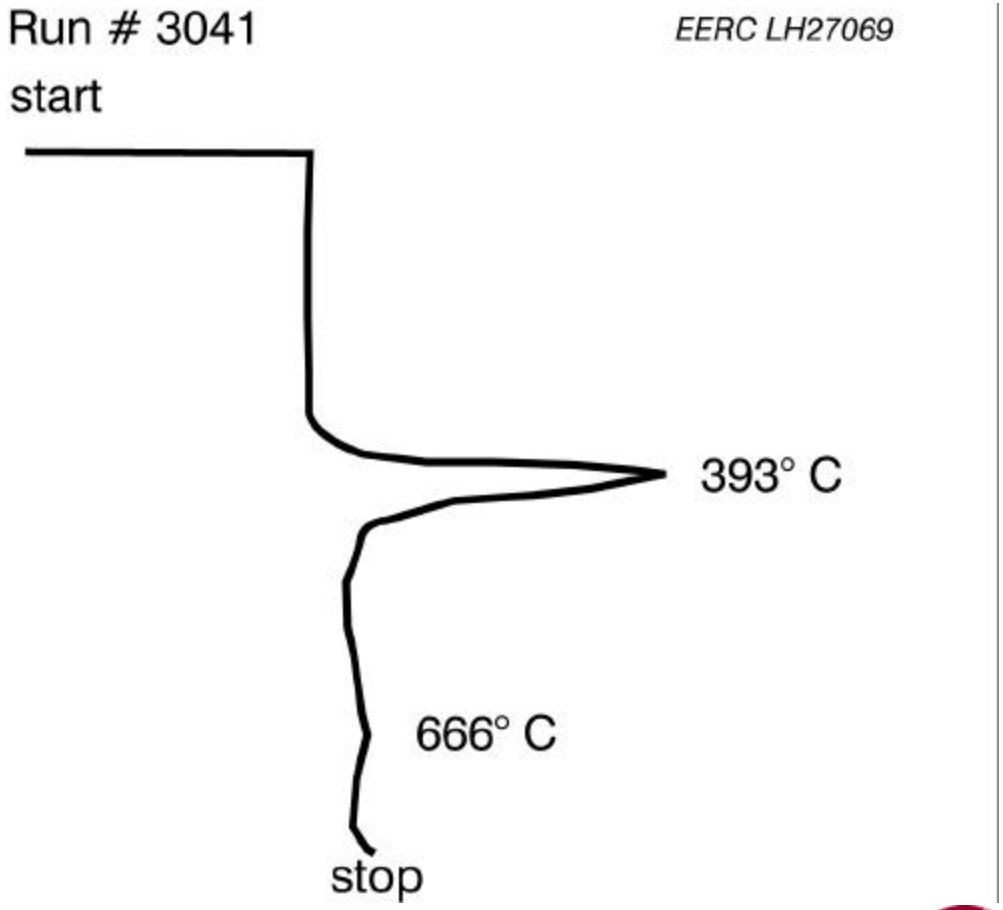
Hg Thermal Desorption from Fly Ash Sampled During SEA2 and PAC Injections



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Preliminary Conclusions

- Lignite combustion flue gas at MRY Unit 2 contained primarily Hg^0 (>70%).
- SEA2 was more effective in enhancing ESP–FGD Hg removal relative to $CaCl_2$ and $MgCl_2$.
- ESP–FGD Hg removals of $\geq$55% were maintained by injecting 60-100 ppm SEA2 and 0.15 lb/MMacf.

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Preliminary Conclusions (continued)

- SEA2 additions may have promoted $CaSO_4$ deposition.
- The Hg in baseline and SEA2- and PAC-containing fly ashes was insoluble.
- The Hg in SEA2- and PAC-containing fly ash was thermally more stable relative to baseline fly ash.

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