REINHOLD ENVIRONMENTAL Ltd.

2010 APC Round Table
& Expo Presentation

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NALCO Mobotec

Combustion Improvement and Multi-pollutant Control

Mercury Speciation Control in Coal-Fired Power Plants

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Essential Expertise for Water, Energy and Air℠

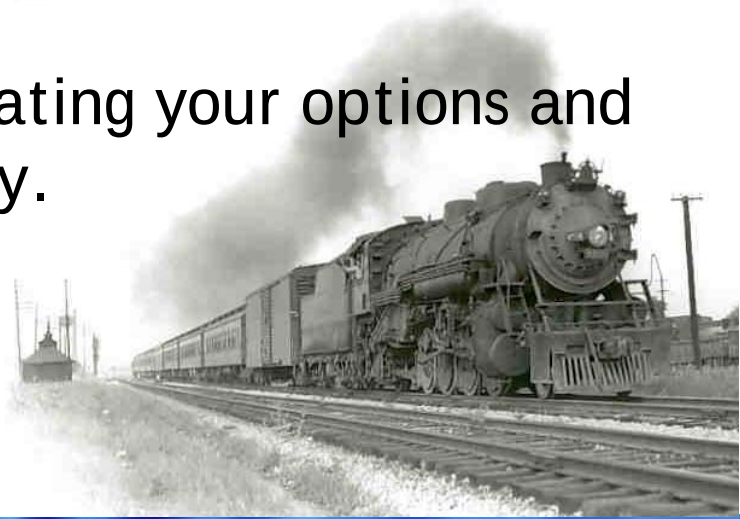
Presentation Outline

- Background Information
- Case Studies
- Summary/Questions

Sustaining Clean Air and Water

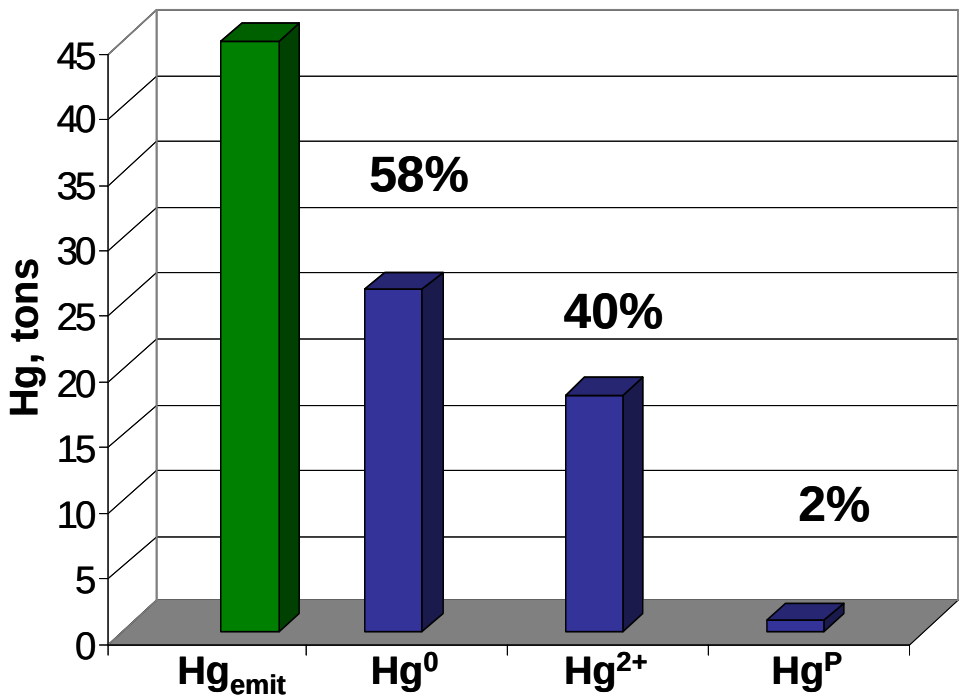
Mercury Control Regulatory Status

- Industrial Boiler MACT
- Utility Boiler MACT
- CAIR Legislation
- In the meantime, 20 states have enacted their own Hg regulations
- Now is the time to begin evaluating your options and constructing a mercury strategy.



Flue Gas Mercury Speciation

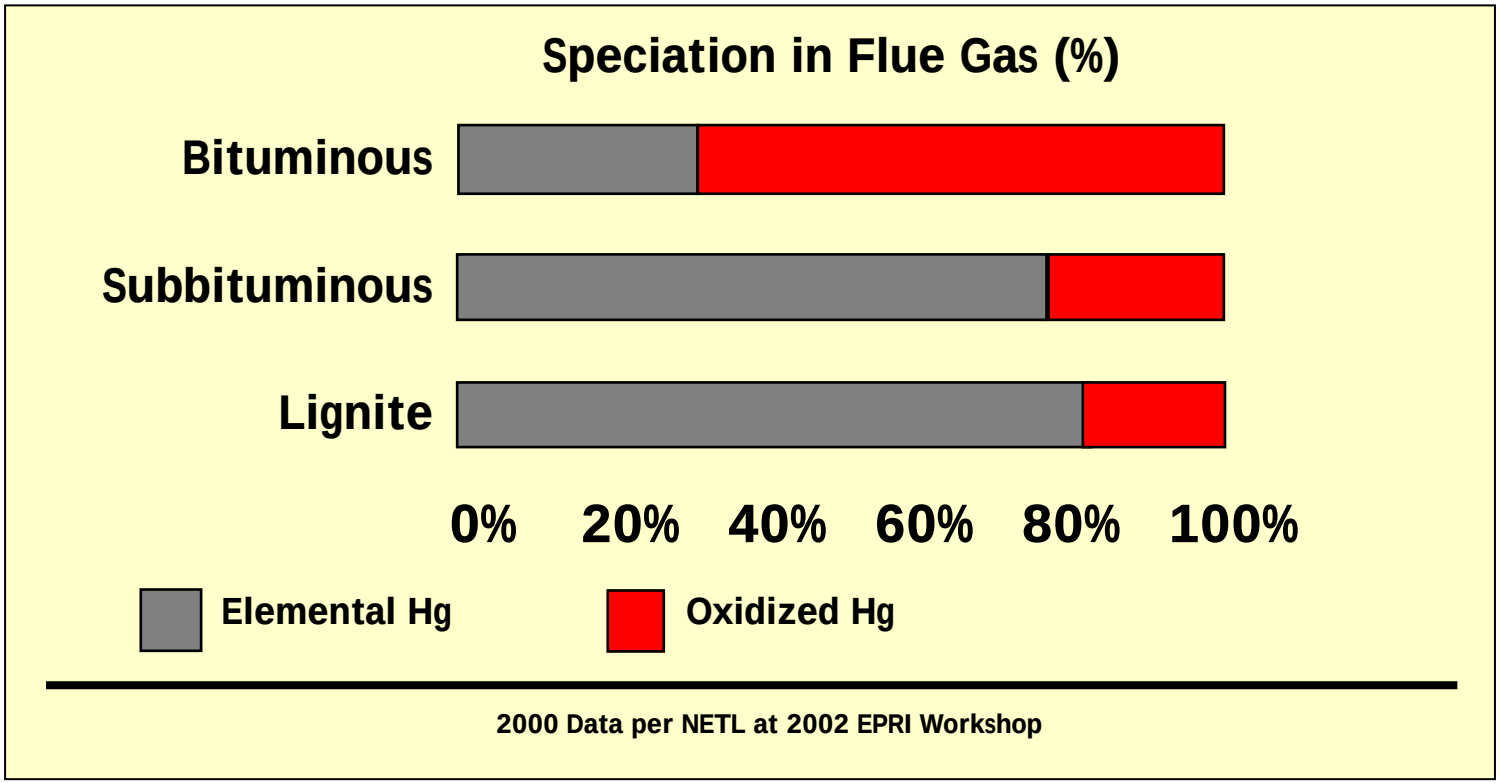
$$Hg_{emit} = Hg^0 + Hg^{2+} + Hg^P$$



- In 1999, 45 tons of Hg exited US coal-burning power plants (Hg_{emit})
- Hg^0 is "difficult to capture".
- Hg^{2+} is "easily captured".
  - Soluble in water
  - Readily captured by ACI

"Multipollutant Emission Control Technology Options for Coal-fired Power Plants," EPS Report EPA-600/5-05/034, March 2005, E.S. Tavoulareas, Energy Technologies Enterprises Corp, and W. Jozewicz, ARCADIS G&M Inc.

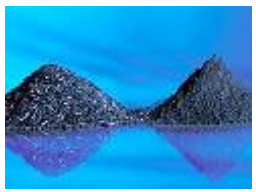
Mercury Speciation by Fuel Type



Influences:

Chlorine Chemistry Council home

Flue Gas Composition
(i.e., Chloride, sulfur)

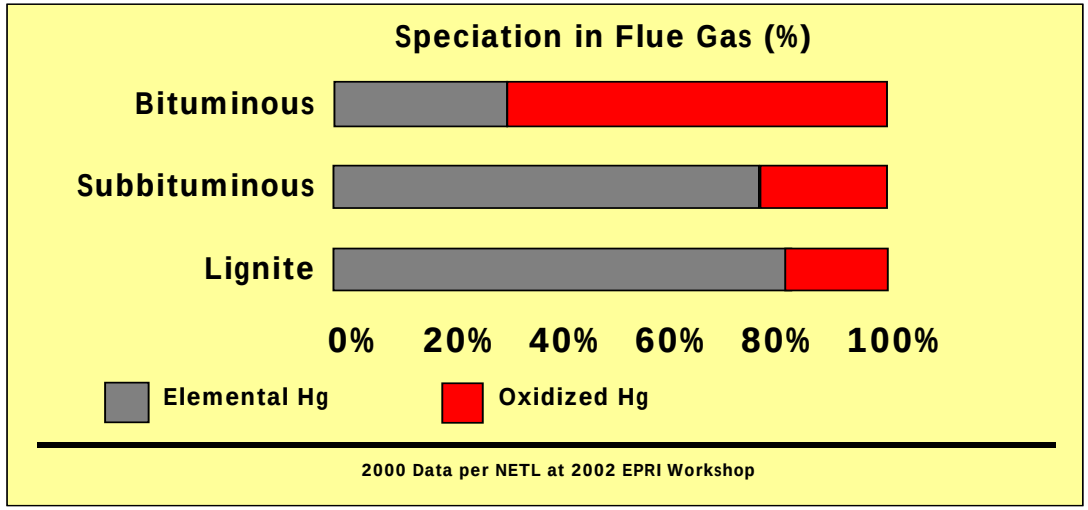


Unburned Carbon
(UBC or LOI)

Catalysts
(i.e., SCR, induct)

Strategies to Increase [Hg^{2+}] in Flue Gas

[Hg^{2+}] in flue gas correlates with chlorine content of coal.



To Increase [Hg^{2+}] in Flue Gas:

- Coal blending→ Mix high chlorine coal with low chlorine coal
- Control Hg speciation with patented application of MerControl® 7895
  - ✓7895 is 10 times more effective than chlorine
  - ✓7895 can increase [Hg^{2+}] in flue gas to 75-90% of [Hg^{T}].

Mercury Control Methodology

- Control options require oxidation of elemental mercury to ionic mercury (whether by halogenated sorbents, or BCA).
- The patented application of MerControl 7895 to oxidize mercury and facilitate its capture by sorbents or acid gas scrubbers.
- Ionic mercury is readily adsorbed by activated carbon and is soluble in water (easily removed by acid gas scrubbers).
- Predominately used for low halogen fuels (PRB) but has shown benefit on even high chlorine fuels up to **1600 ppm Cl content.**

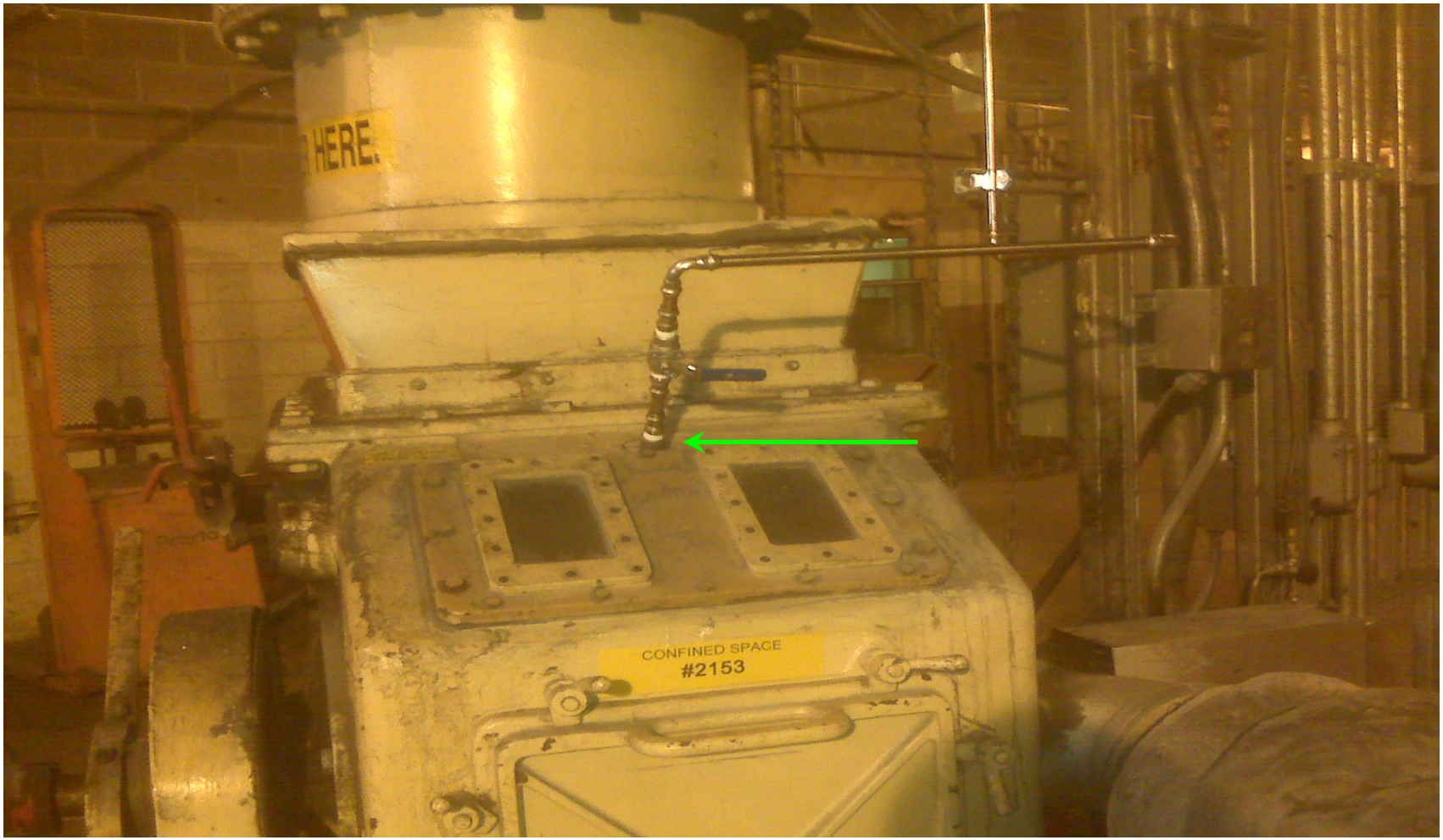
MerControl 7895 Technology

Feed Equipment

Addition Point

The application of MerControl 7895 technology to improve the efficiency of mercury capture from flue gas is patented and exclusively licensed to Nalco Mobotec.

MerControl 7895 Application Point



Case Studies

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Case Study 1

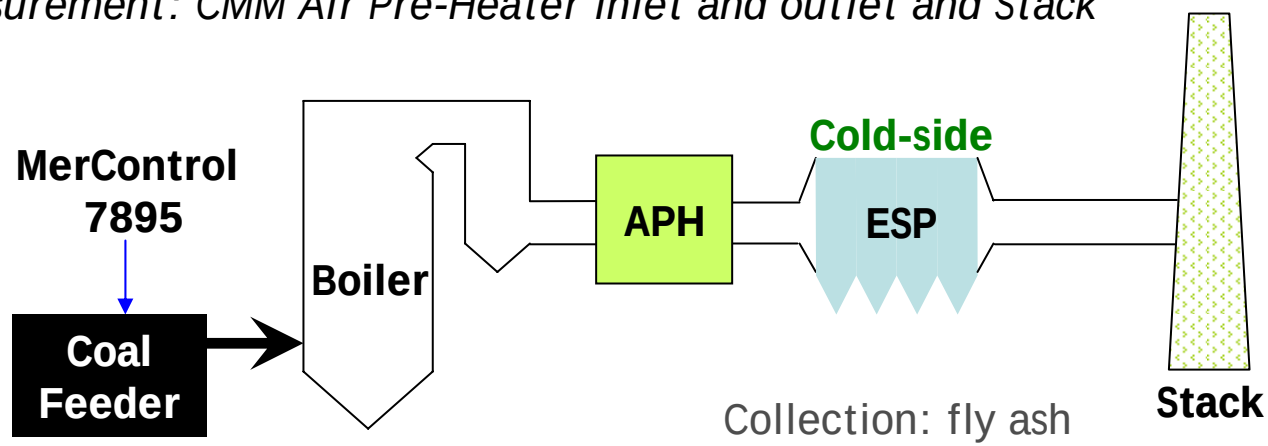
Concrete-Friendly Solution Introduction

Site Description:

- Chlorine* = 100ppm (max = 400)
- Mercury* = 0.08ppm (max = 0.21)
- Full Load = 600 MWe
- Boiler Type = PC, Opposed-Wall Firing
- Fuel = PRB, sub-bituminous coal (4 sources)
- AQCDs = Low NO_x burners, Over-fired air, cold-side ESP

Goal: Achieve 90% Hg Capture[1] while maintaining concrete sales of fly ash.

Hg measurement: CMM Air Pre-Heater inlet and outlet and Stack



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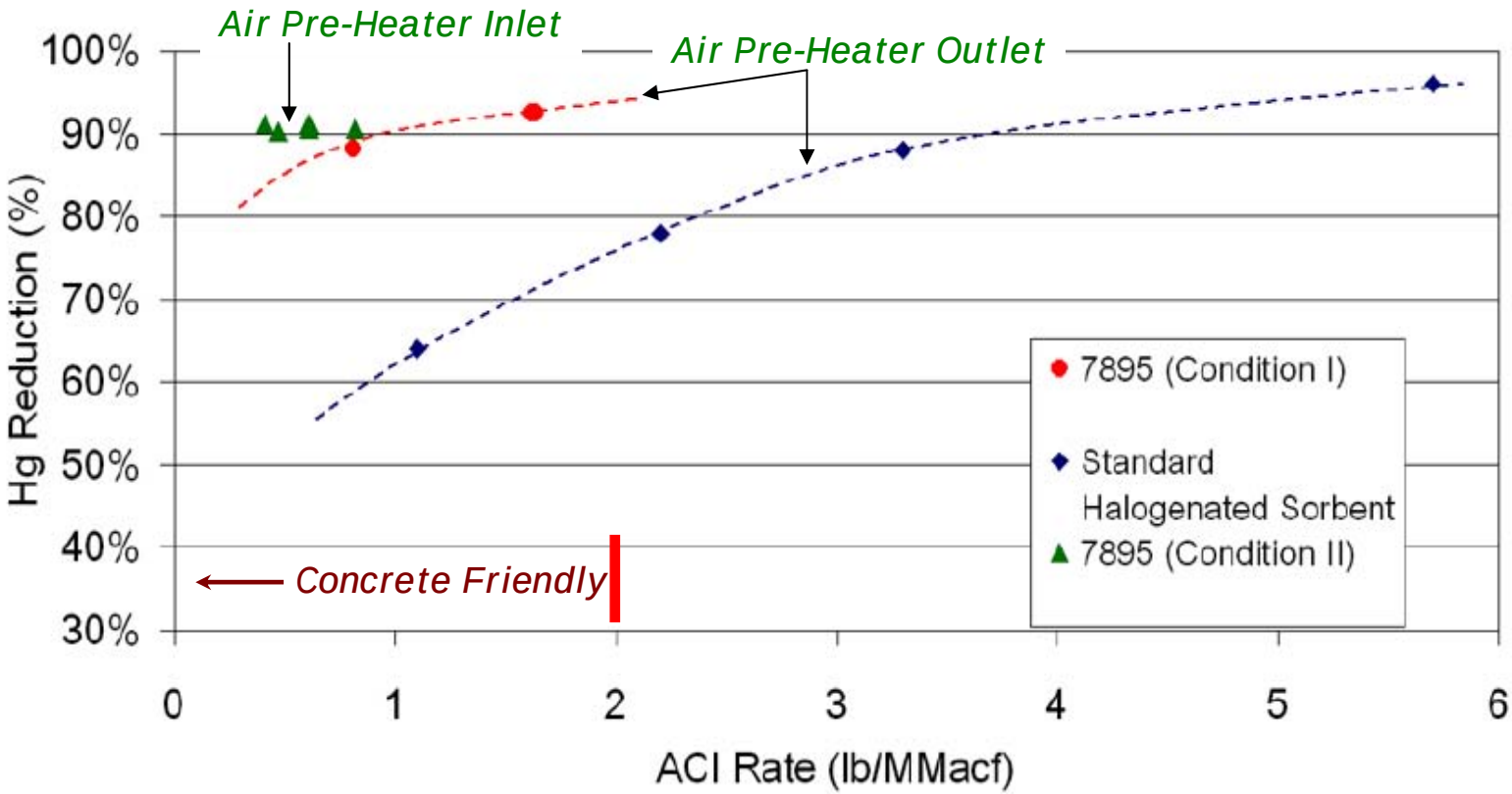
[1]Air Heater Inlet to Stack

Case Study 1

Native Capture = 32-38% **MerControl 7895 Alone = 63-65%**



Air Pre-Heater Outlet Findings

- **Halogenated PAC failed below 3.3lb/MMacf**
- **420ppm MerControl 7895/1.6lb/MMacf PAC met Goal.**

Air Pre-Heater Inlet Findings

- **120ppm MerControl 7895/0.41lb/MMacf PAC met Goal.**

Case Study 1: Summary

- **Only concrete friendly solution** for customer that reaches 90% mercury removal and allows sale of fly ash.

- **Reduced activated carbon consumption by 66%** compared to other specialty sorbents tested.

- **Reached 90% mercury capture at 0.41#/Mmacf ACI injection rate with 120mg/kg MerControl 7895 utilizing only an ESP unit.**

Case Study 2

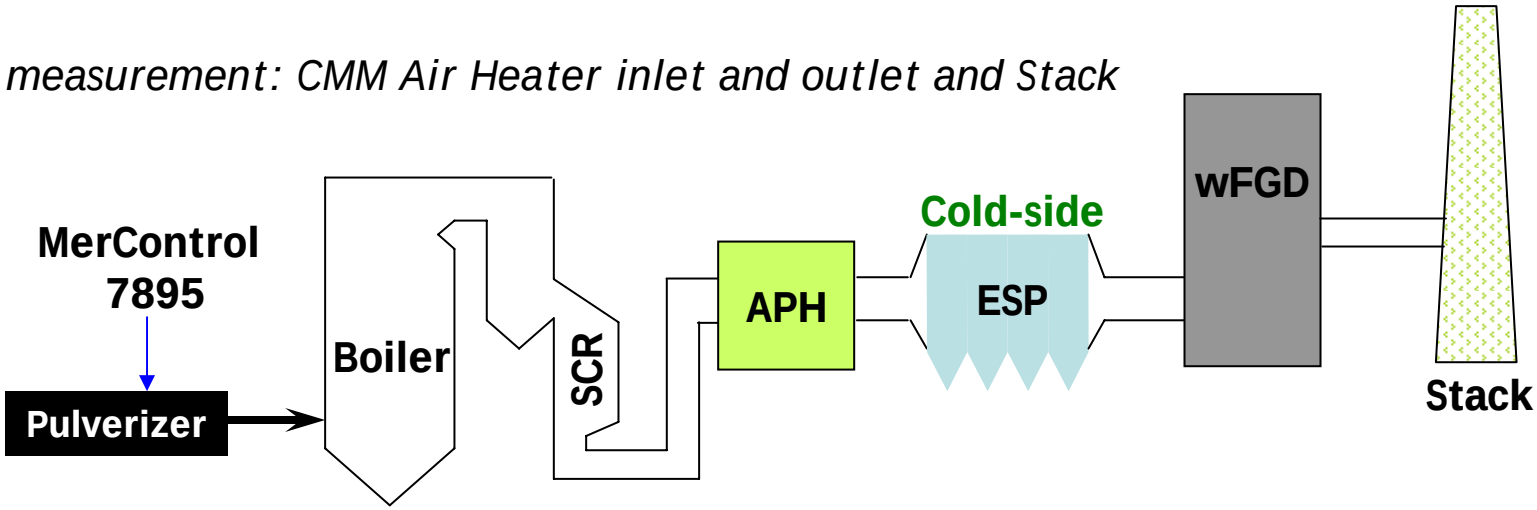
Site Description:

- Chlorine* = 1200 ppm (max = 1400)
- Mercury* = 0.05 ppm (max = 0.06)

- Full Load = 195 MWe
- Boiler Type = PC, Tangentially Fired
- Fuel = High Chlorine Bituminous
- AQCDs = SCR, cold-side ESP and wFGD

Goal: Achieve 90% Hg Capture[1] ***and*** meet mercury water discharge regulations.

Hg measurement: CMM Air Heater inlet and outlet and Stack



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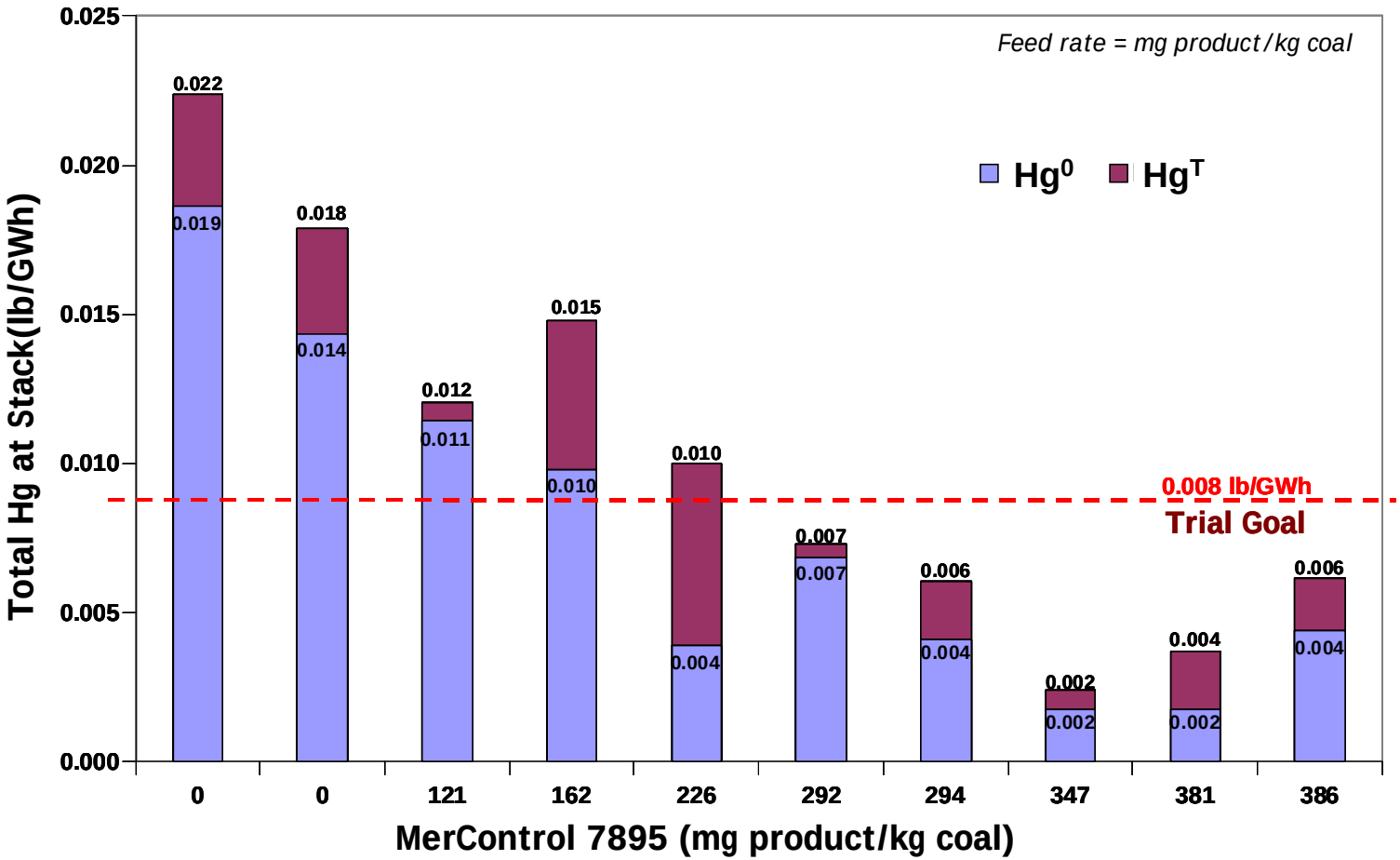
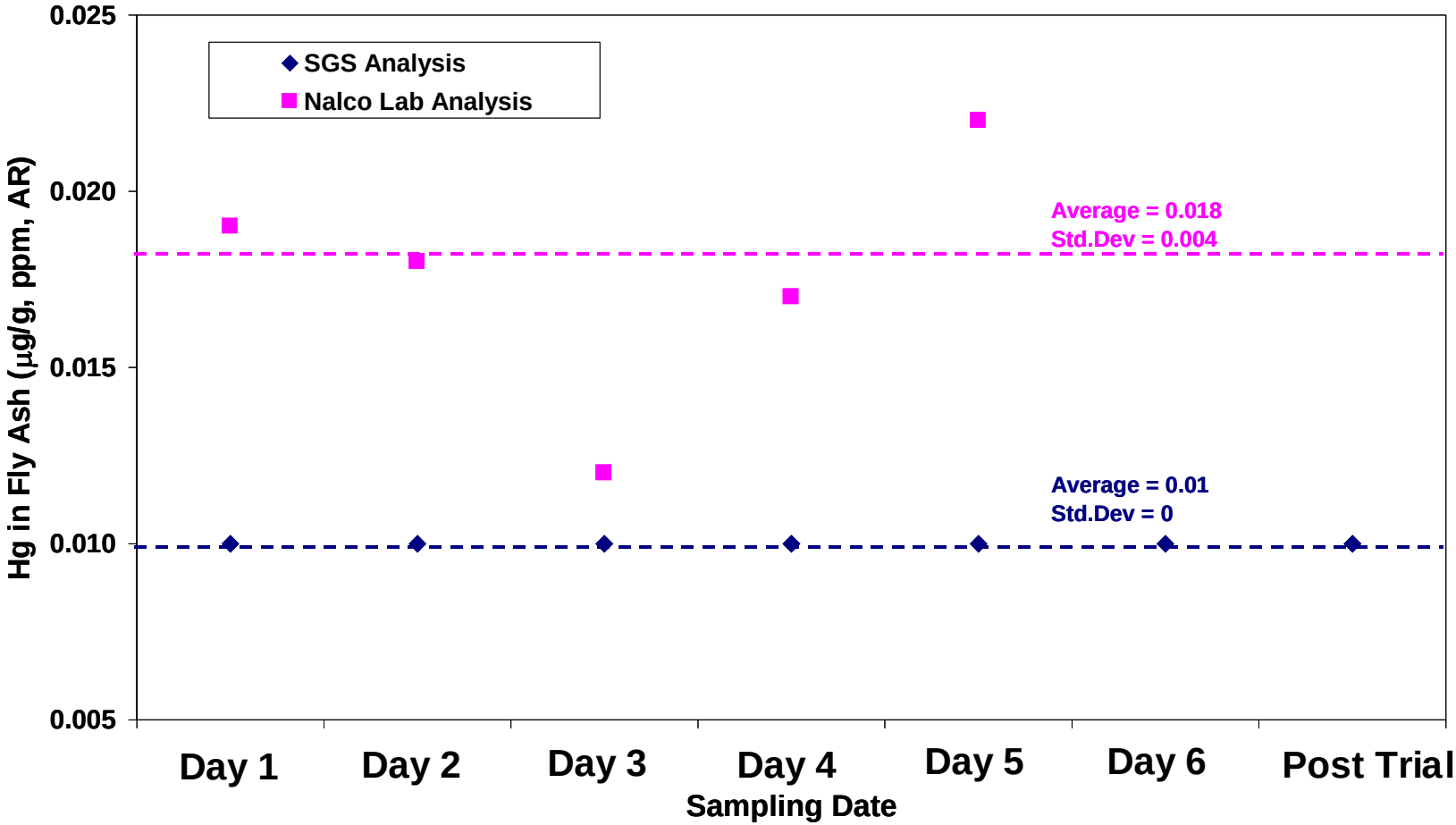
[1]Air Heater Inlet to Stack

Case Study 2: Hg Speciation at the Stack



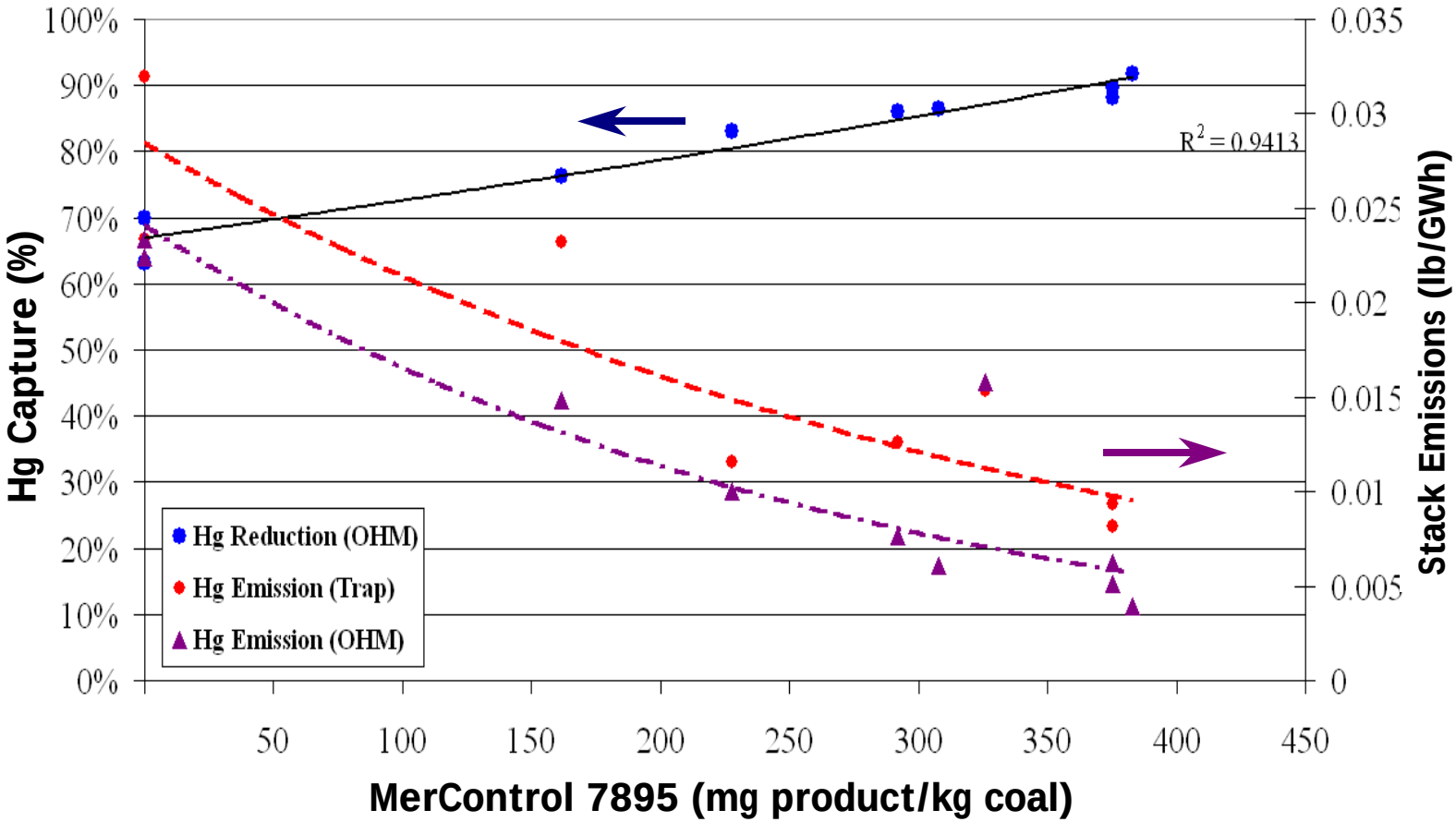
- Lower elemental Hg fraction as 7895 dose increases.
- Hg emission reduction at stack driven by MerControl 7895 technology.

Case Study 2: Fly Ash Mercury Capture



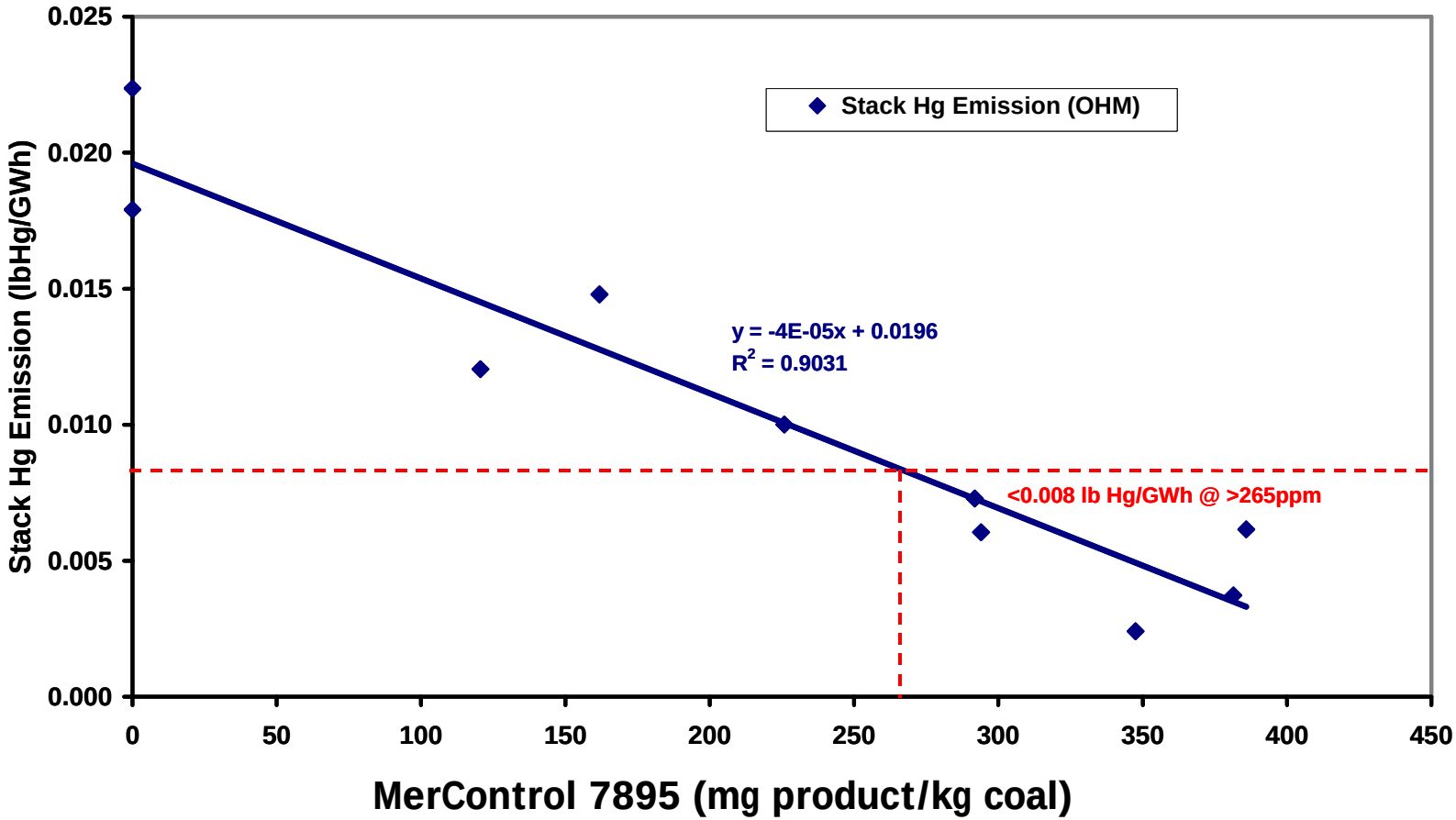
➢Little or no Hg capture by fly ash.

Case Study 2: Mercury Emissions and Capture



➢**0.008 lb/GWh Mercury emissions met with MerControl 7895 technology.**

Case Study 2: Application of MerControl 7895 Drives Higher wFGD Hg Capture

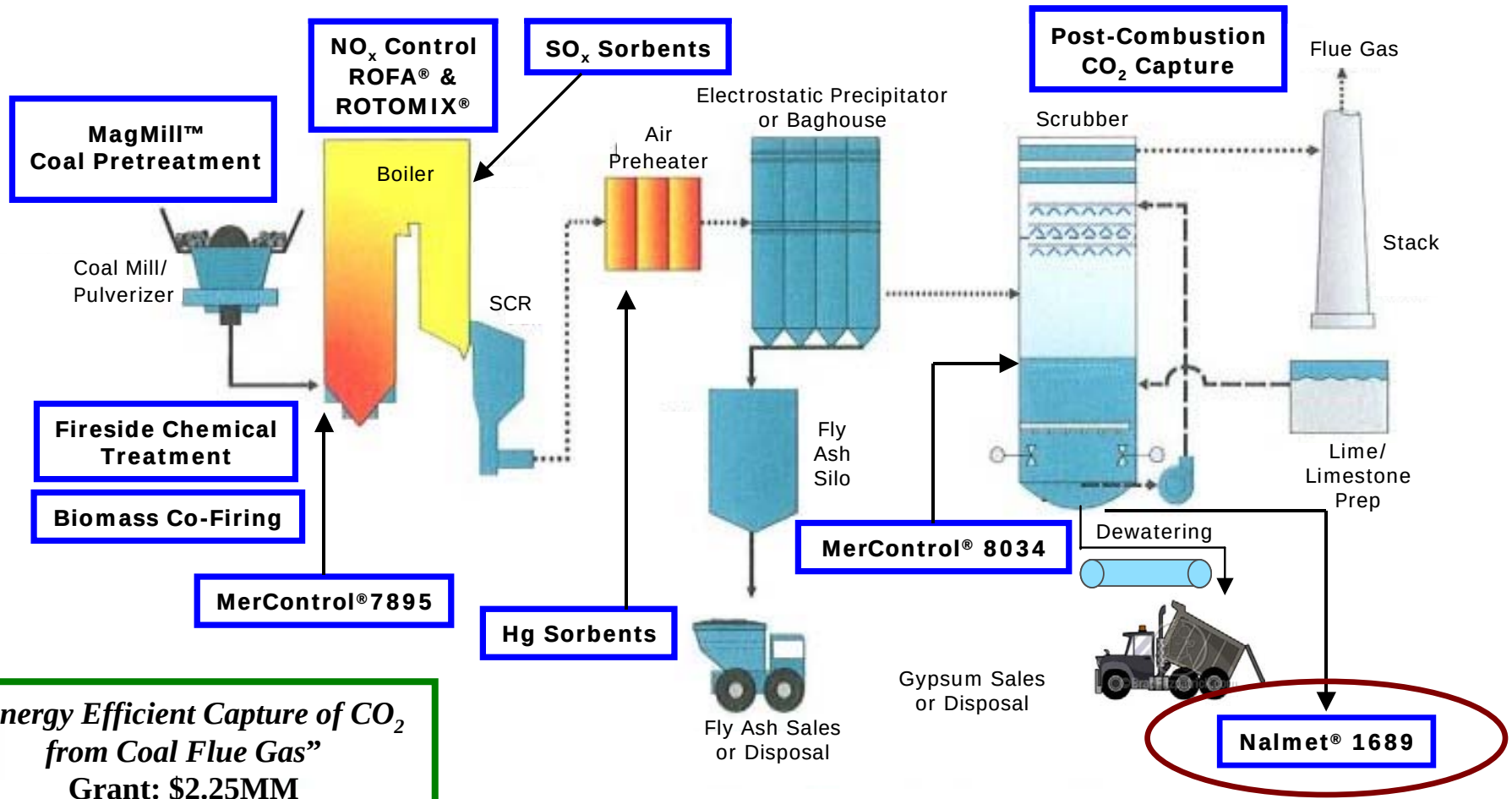


- Linear relationship between stack emissions and 7895 dose.
- Trial goal met at greater than 265 mg 7895 /kg of coal.

Case Study 2: Conclusions

- $[Hg^{2+}]$ fraction in flue gas of a high chlorine coal was increased.
- Greater than 85% Hg capture (coal to stack) was realized at 265 mg MerControl 7895 /kg coal.
- Capital requirements are minimal going forward.
- Where did the mercury go?

"Small Environmental Footprint"
Coal-Fired Power Plant

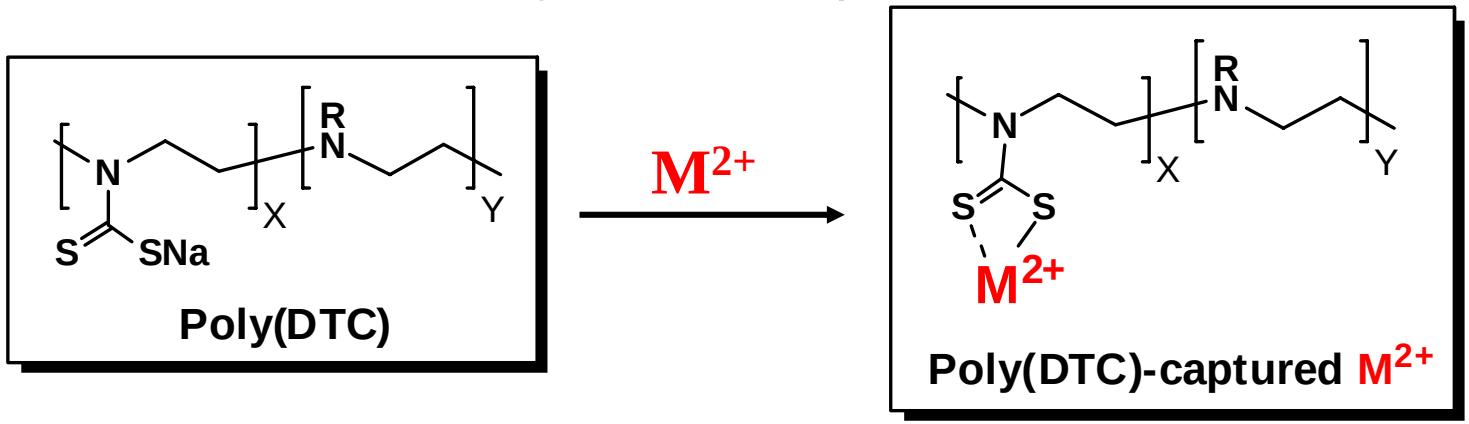


"Energy Efficient Capture of CO_2 from Coal Flue Gas"
Grant: $2.25MM
Grant: DE-AR0000024

Holistic Approach to design and implementation of Solutions

Wastewater Treatment Application Background

- Nalmet 1689 – A Patented Polymeric Precipitant

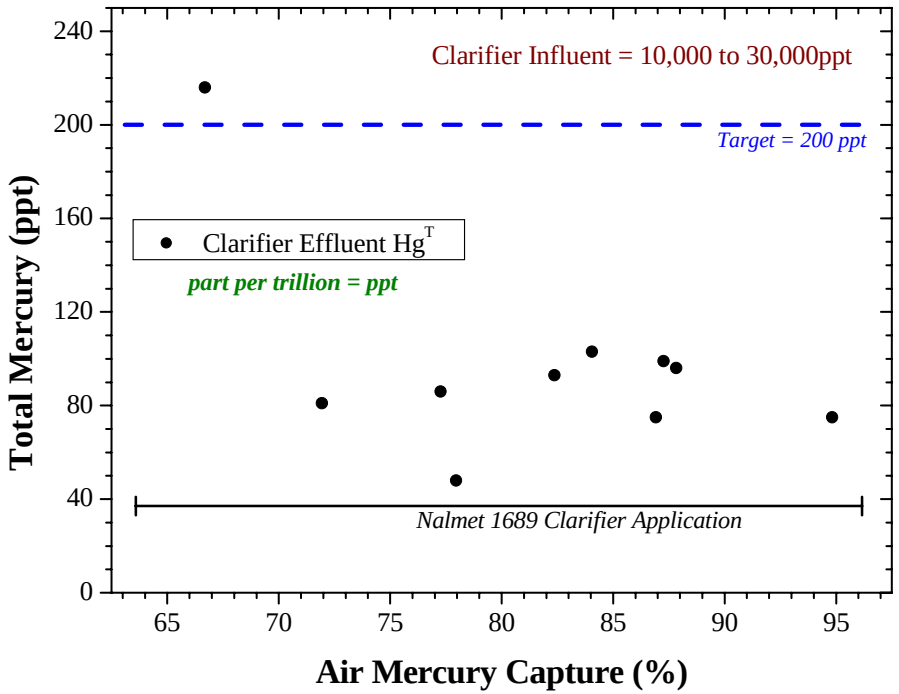


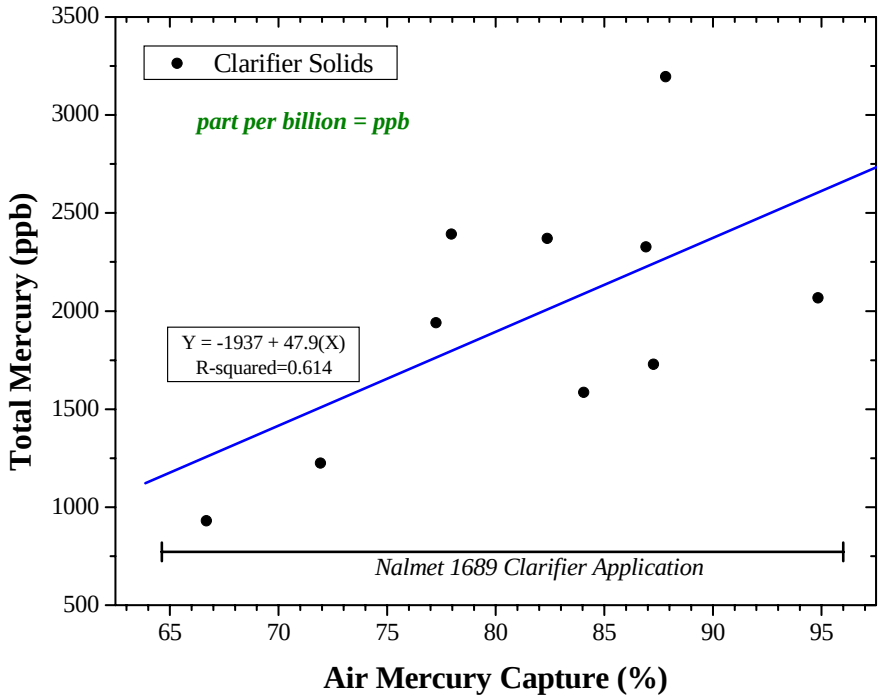
- Selectivity for Metals

  Hg > Ag > Cd > Cu > Pb > Zn > Co(II) > Ni > Fe(II) > Mn

Poly(DTC)'s polymeric form provides improved floc formation

Sustaining Water





Clarifier Influent was 10,000 to 30,000ppt historically.

Hg in clarifier solids increased during trial.

N1689 being fed to Clarifier during trial.

- **Hg "load" at clarifier increased due to increased capture.**
- **Nalmet 1689 maintains low Hg levels in discharge.**

Conclusions

- Application of customized program enabled regulatory compliance for air emissions thereby shrinking the plants environmental footprint.
- Mercury air emission reduced by at least 85% with as high as 95%+ demonstrated.
- Mercury water emission is part of the solution as reduction to low parts per trillion (ppt).

Acknowledgements

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The Research Analytical Group of Nalco

Helpful Personnel at the Test Site.