

REINHOLD ENVIRONMENTAL Ltd.



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Research and Consulting Engineers



2016 APC-Wastewater/PCUG Conference

Edward Village Michigan Hotel
Dearborn, MI 48126

DOWNSTREAM MERCURY BEHAVIOR & EFFECTS ON EMISSIONS

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Agenda

1. Underlying Driving Forces Affecting Mercury Speciation and Capture
2. Short Review of Historical Focus on SCR
3. Air Preheater Behavior
4. ESP Behavior
5. Scrubber Behavior
6. Overall Behavior

Things to Remember

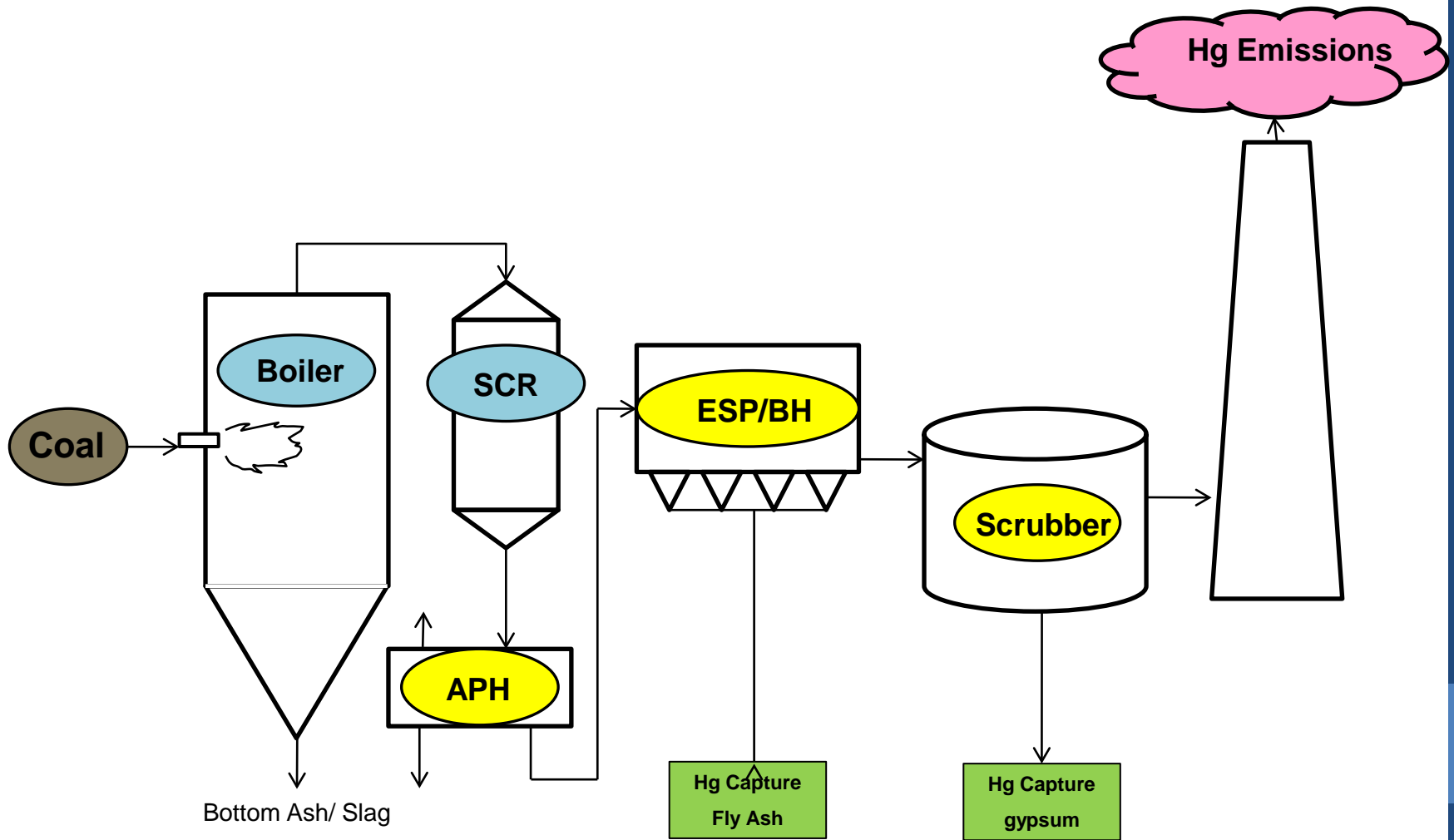
The statistics for a large population of separate devices at multiple conditions do not necessarily hold for a single device at multiple conditions.

Bottom Line: Don't assume your particular device behaves in a certain way unless you have very specific data.

Coal Equivalents for Chlorine

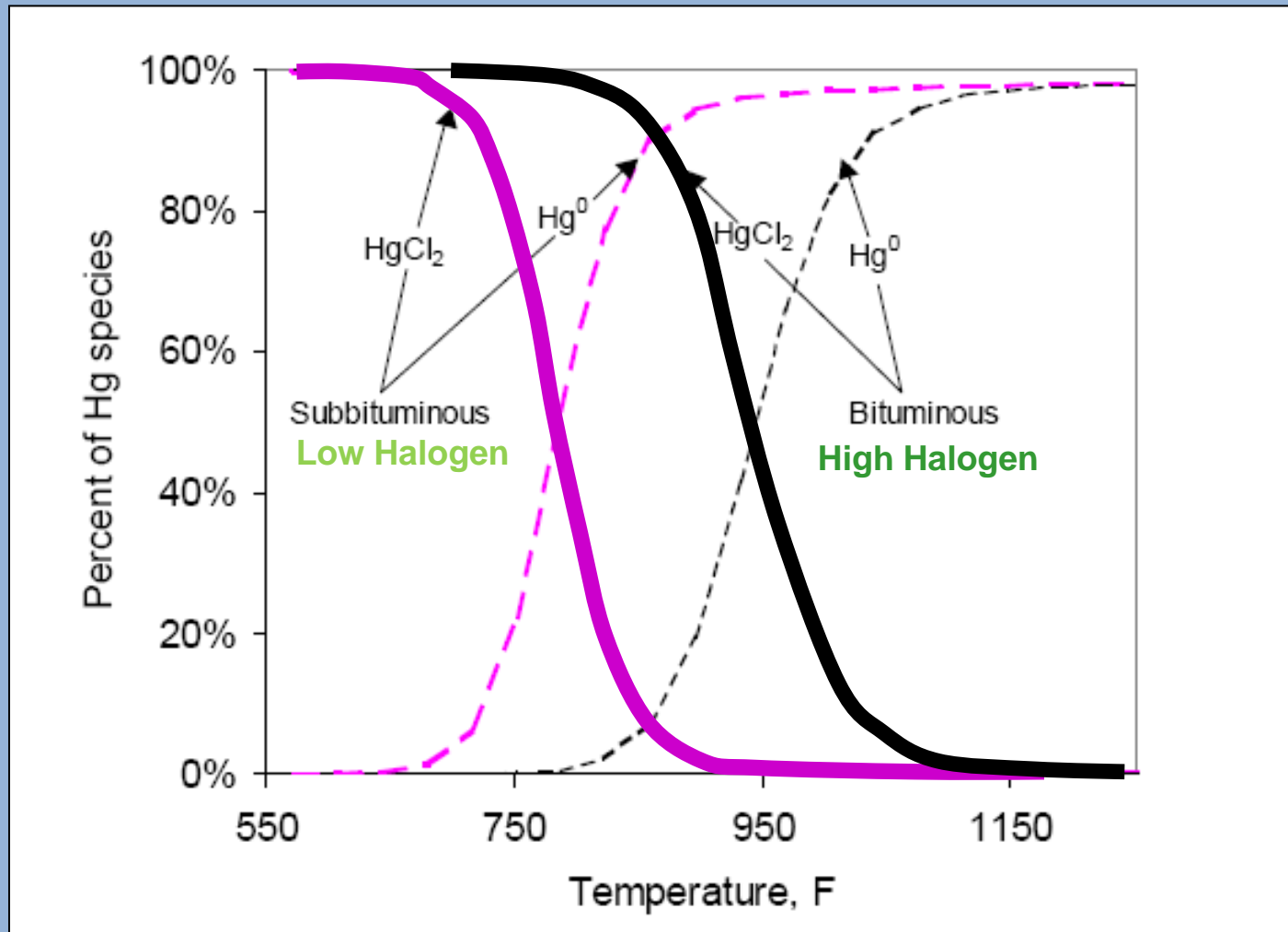
Coal Chlorine (ppmw, dry)	Nominal Gas-Phase Equivalent <u>HCl</u> (ppmv, dry, 3% O ₂)	Coal Type
30	2.3	<u>PRB</u>
100	6.6	
300	20	Southern Appalachian, South American
500	33	<u>Normal EB</u>
700	47	
1000	67	
2000	133	<u>High S, High Cl EB</u>
3000	200	

FLUE GAS TRAIN

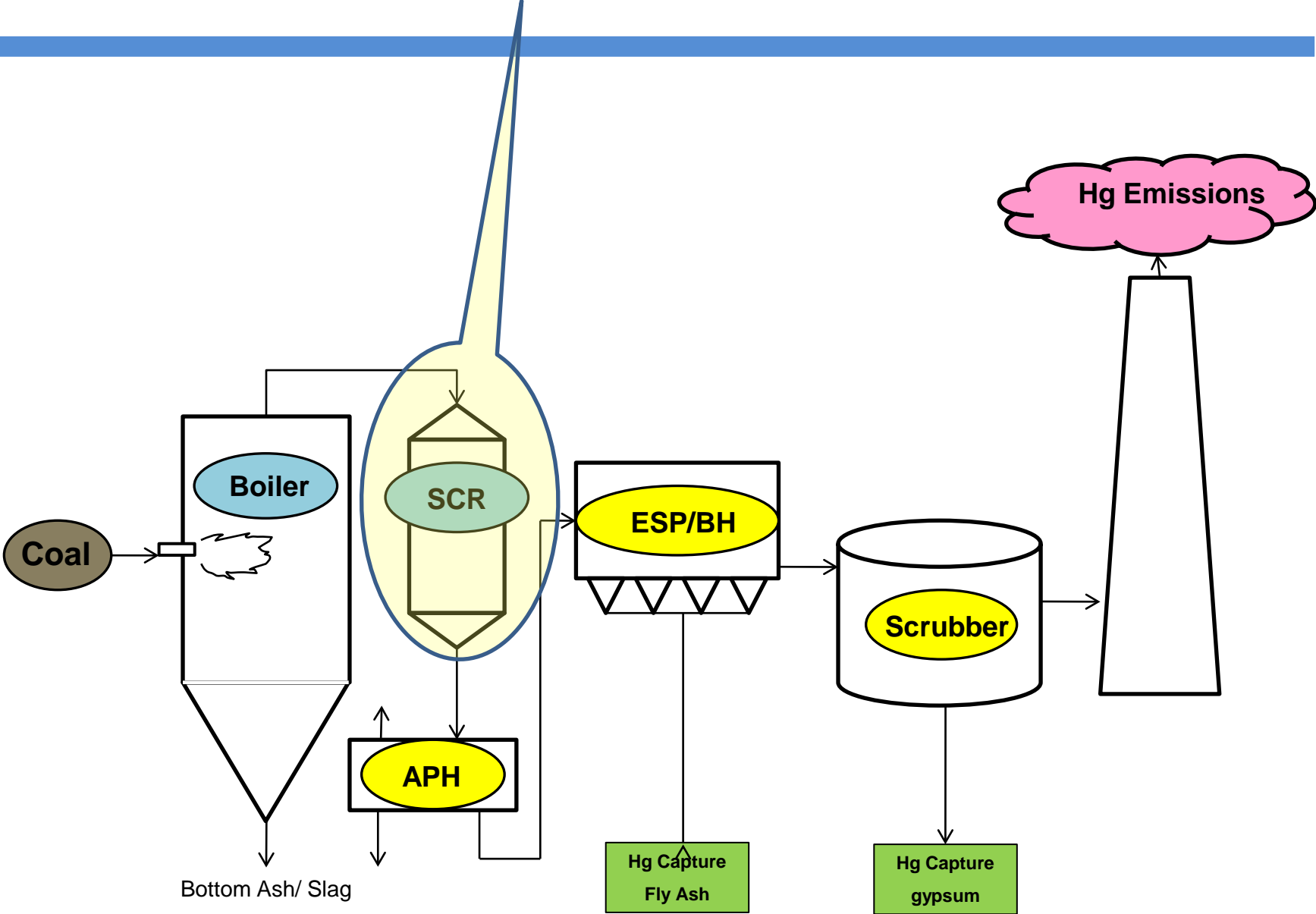


Primary Mercury Behavior Drivers: Temperature and Halogens

Low Temperatures and High Halogens Promote Oxidized Mercury

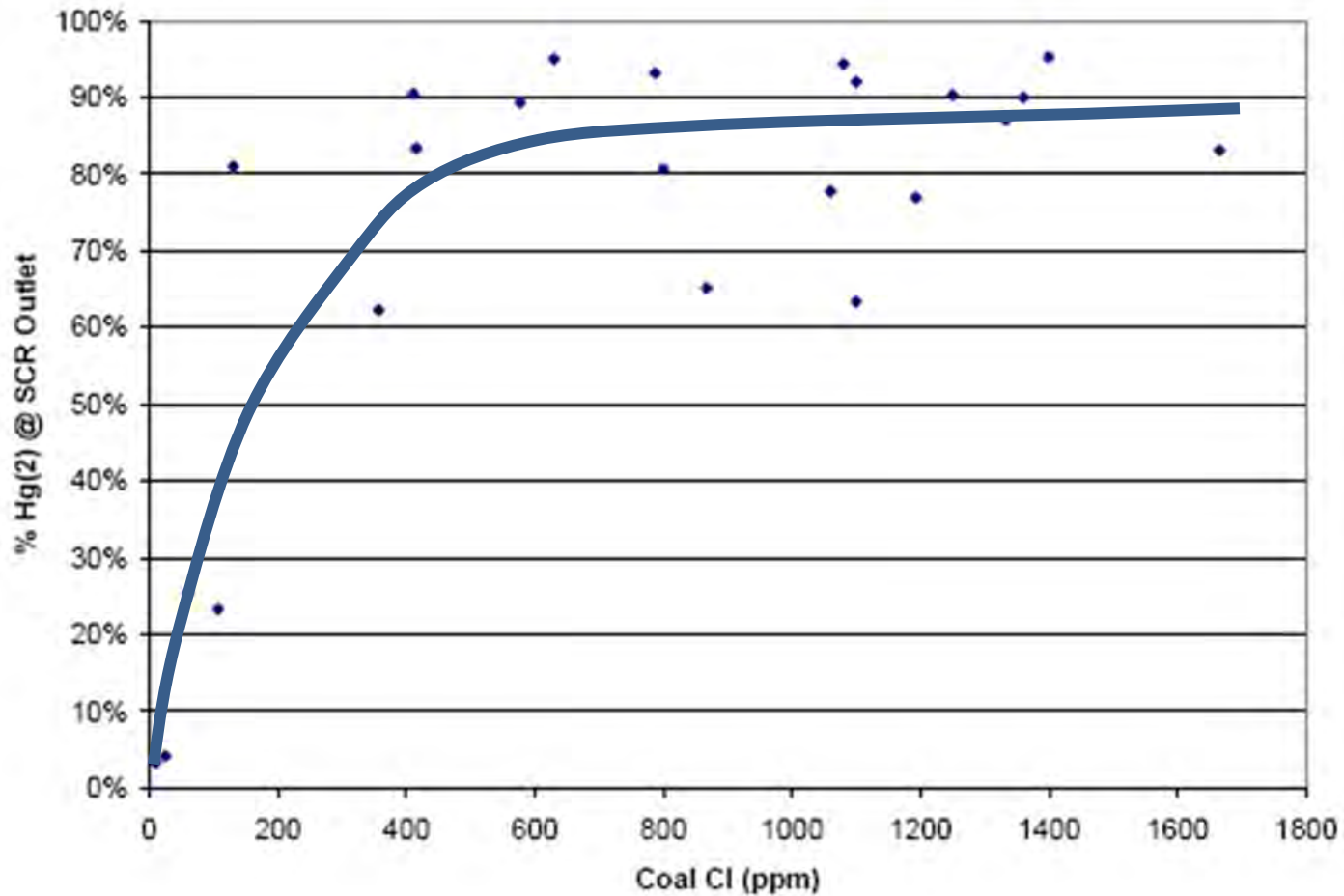


SCR Review



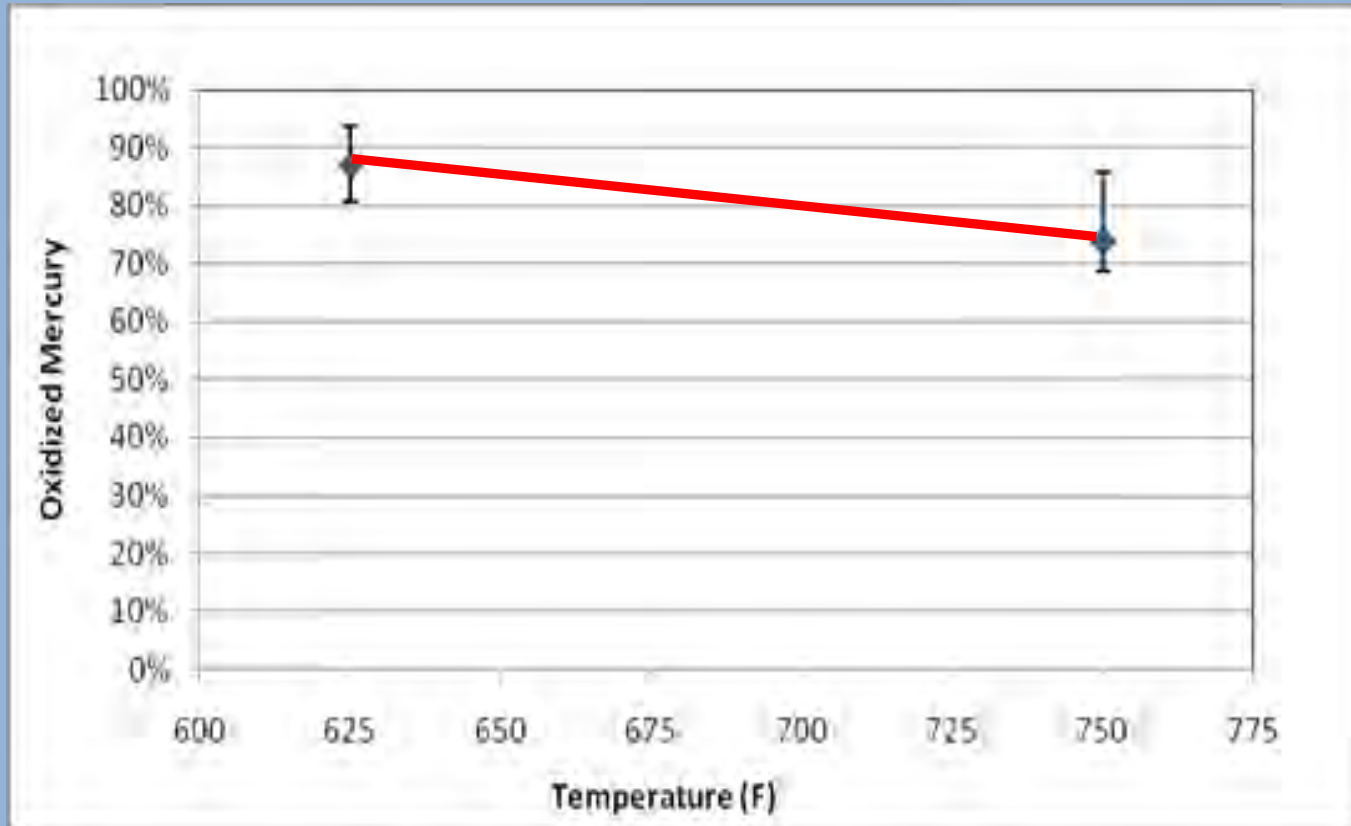
SCR Mercury Behavior: Chlorine

SCR Chlorine response demonstrates classic “knee”



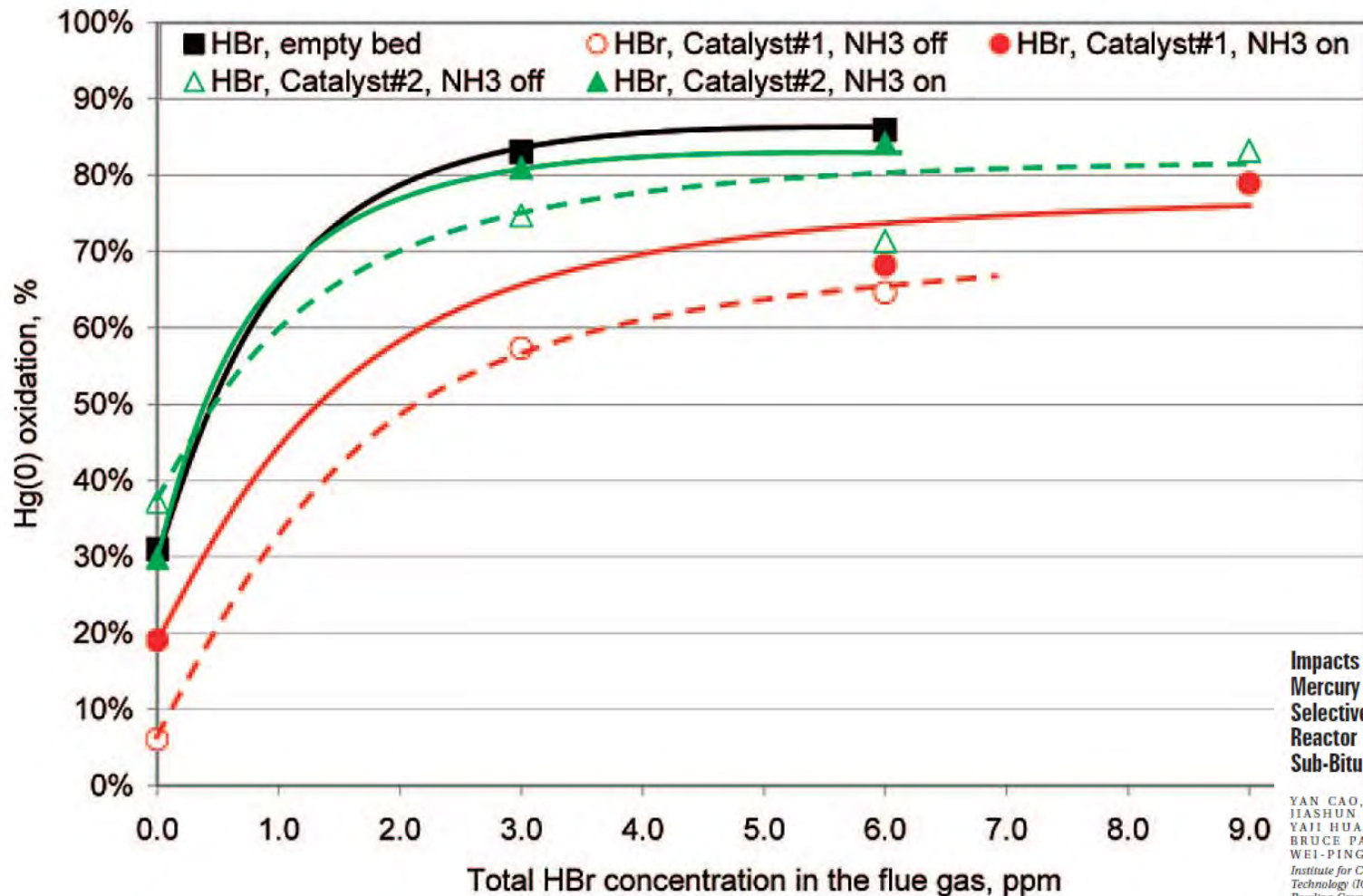
SCR Mercury Behavior: Temperature

Example Pilot Plant Data - well-known adverse effect on SCR Hg oxidation due to temperature



SCR Mercury Behavior: Bromine

bromine is an order of magnitude higher in oxidizing capability than chlorine

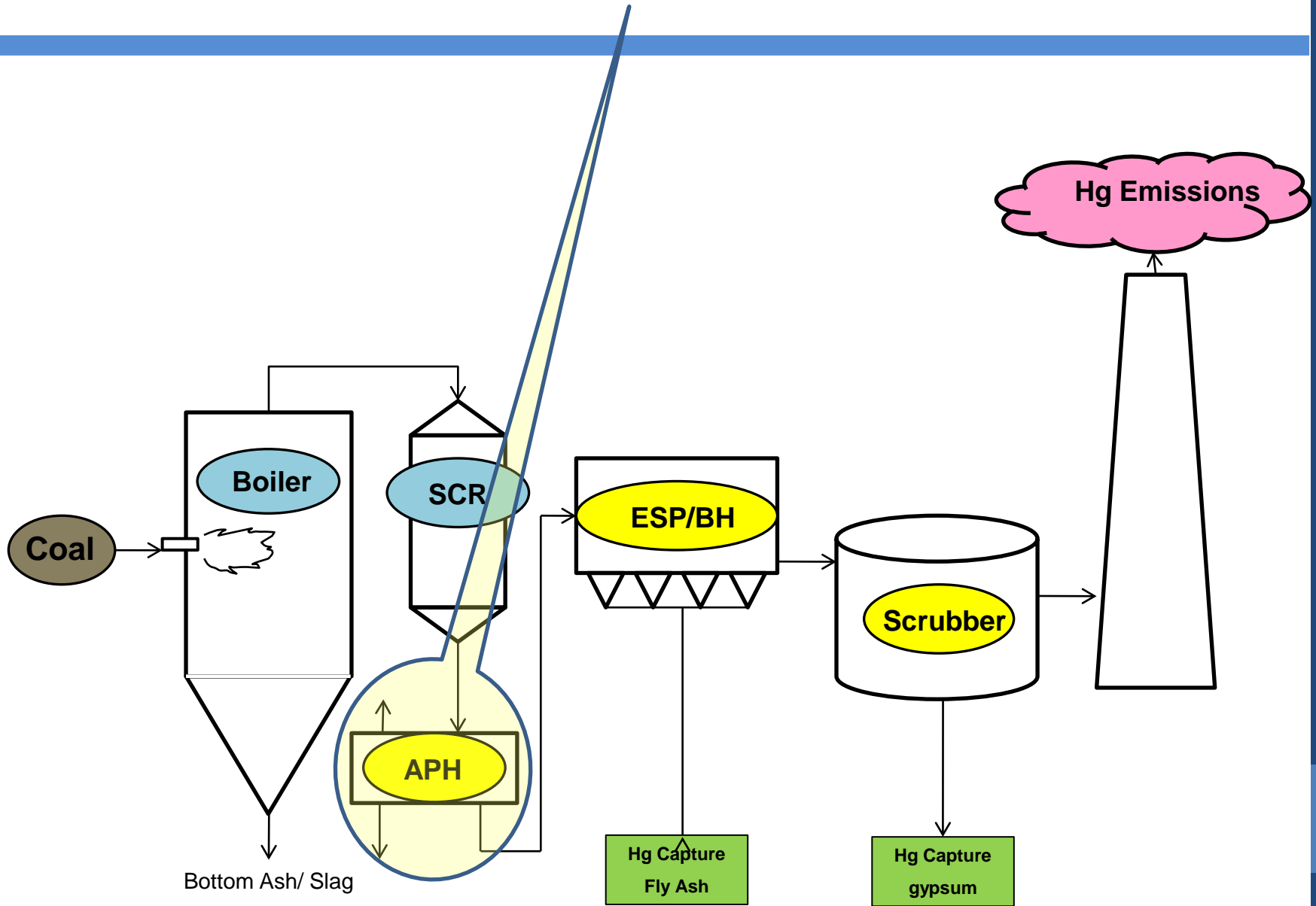


Impacts of Halogen Additions on Mercury Oxidation, in A Slipstream Selective Catalyst Reduction (SCR), Reactor When Burning Sub-Bituminous Coal

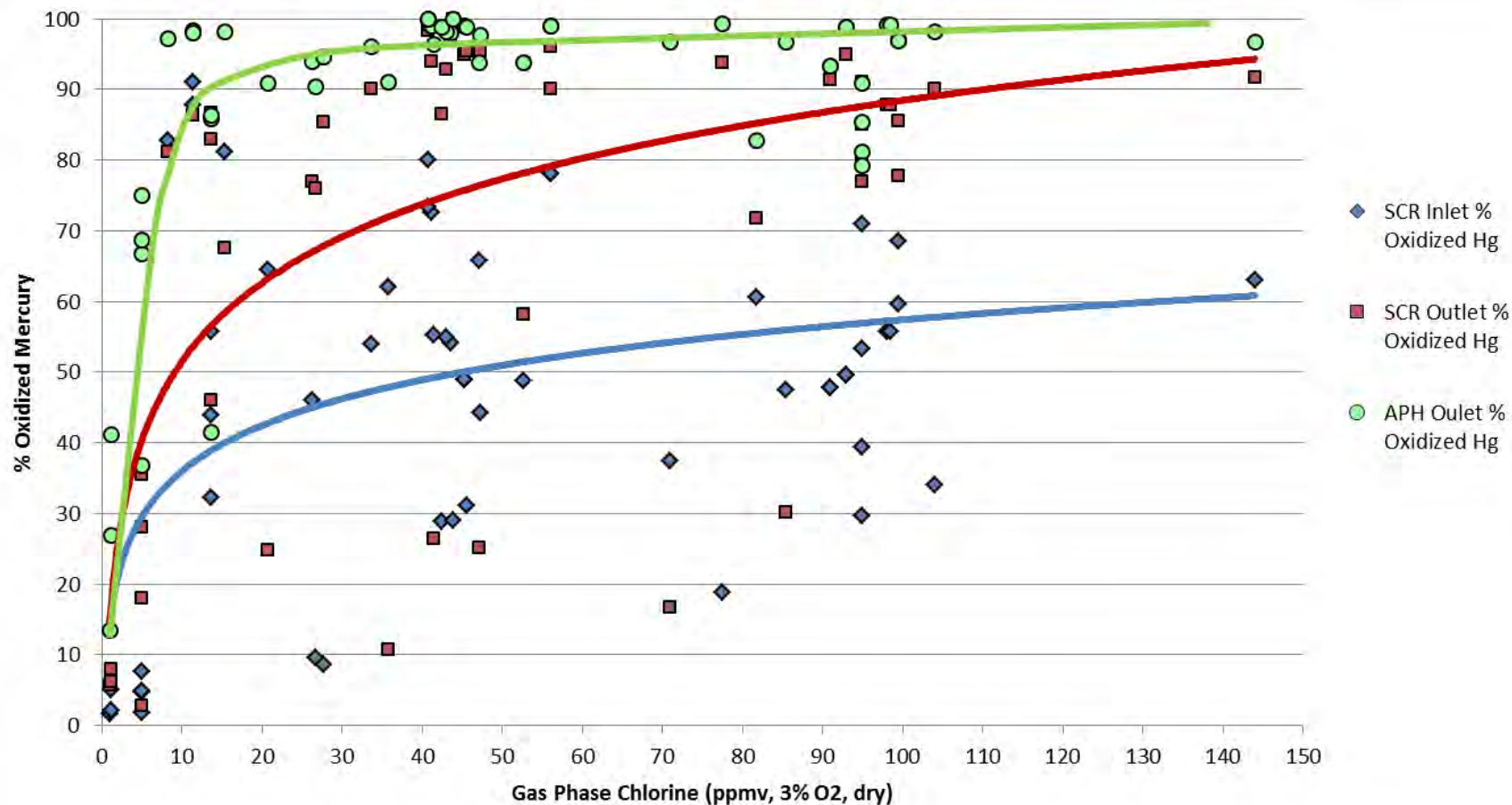
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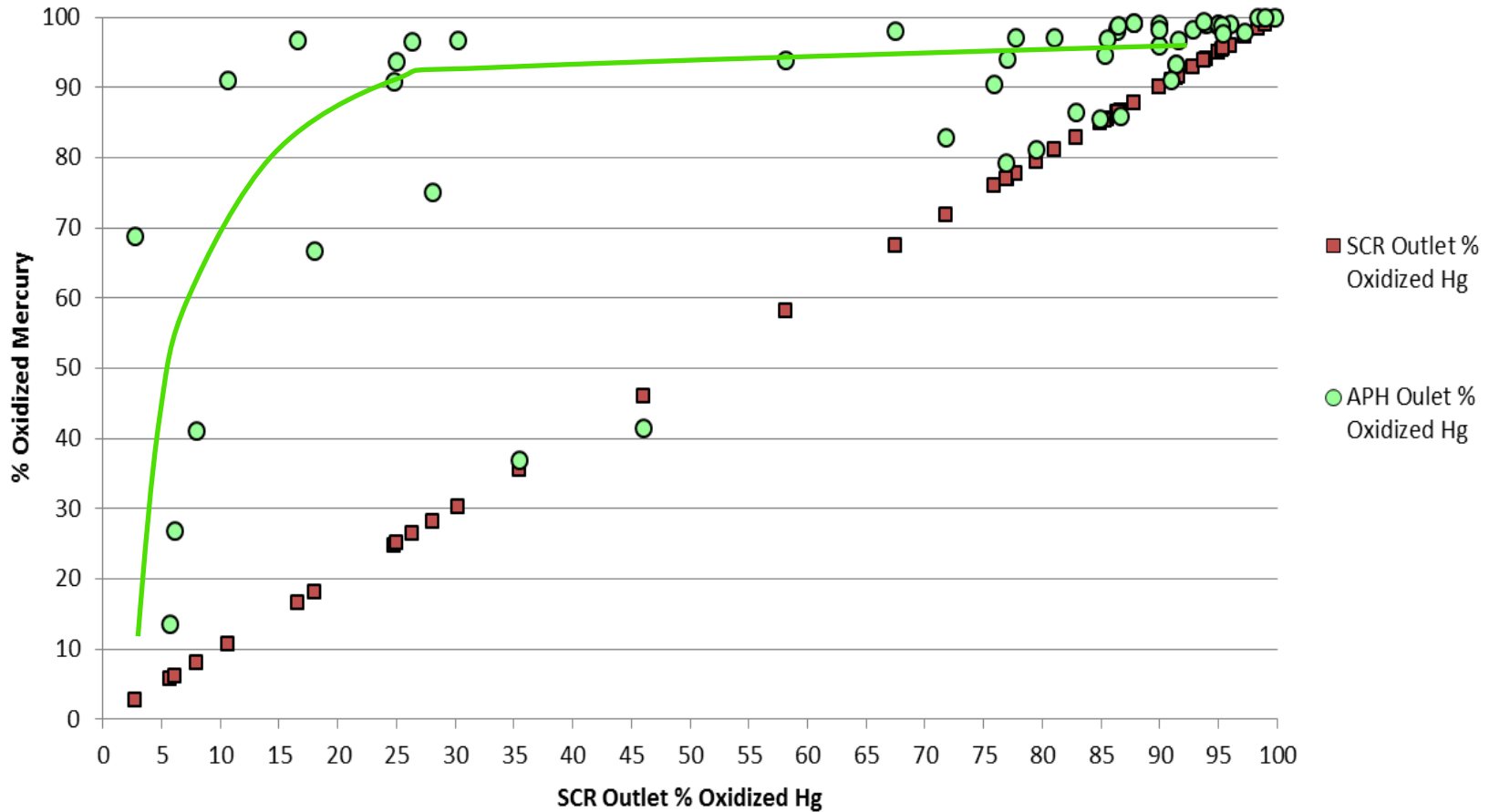
APH Behavior



Air Preheater Outlet Speciation Compared to SCR Inlet and SCR Outlet

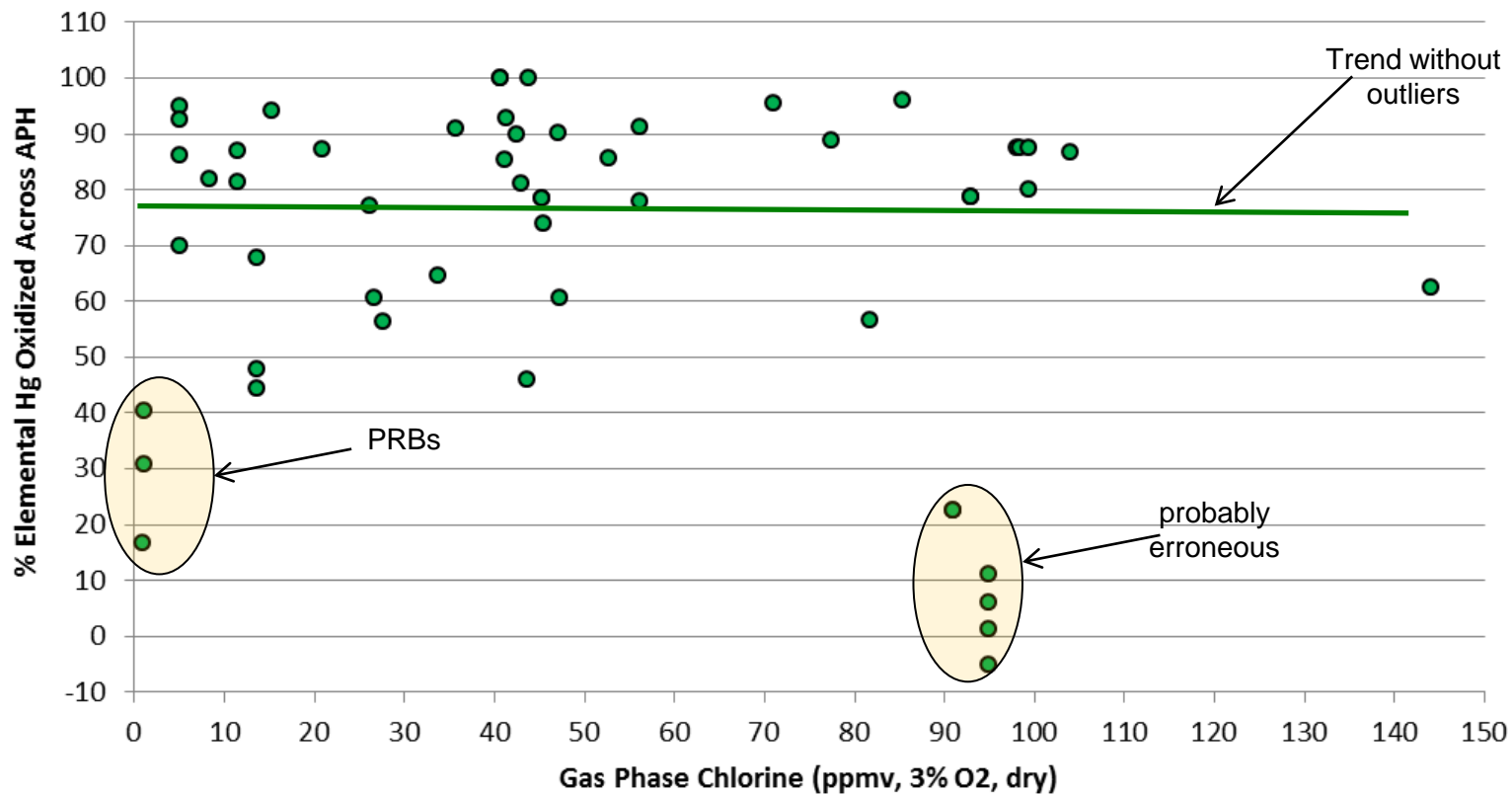


Air Preheater Outlet Speciation as a Function of SCR Outlet Speciation

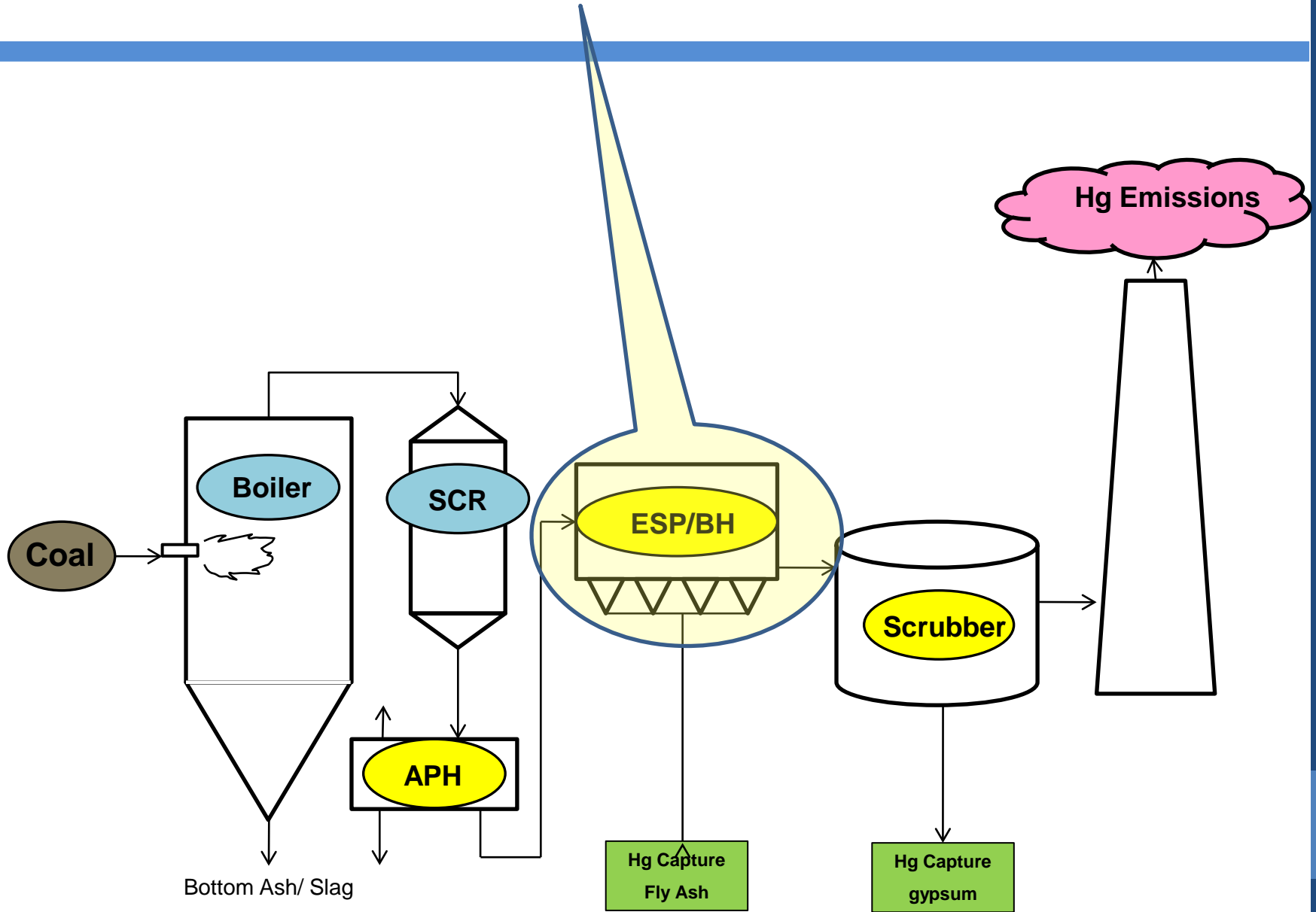


Elemental Hg Oxidized by the Air Preheater

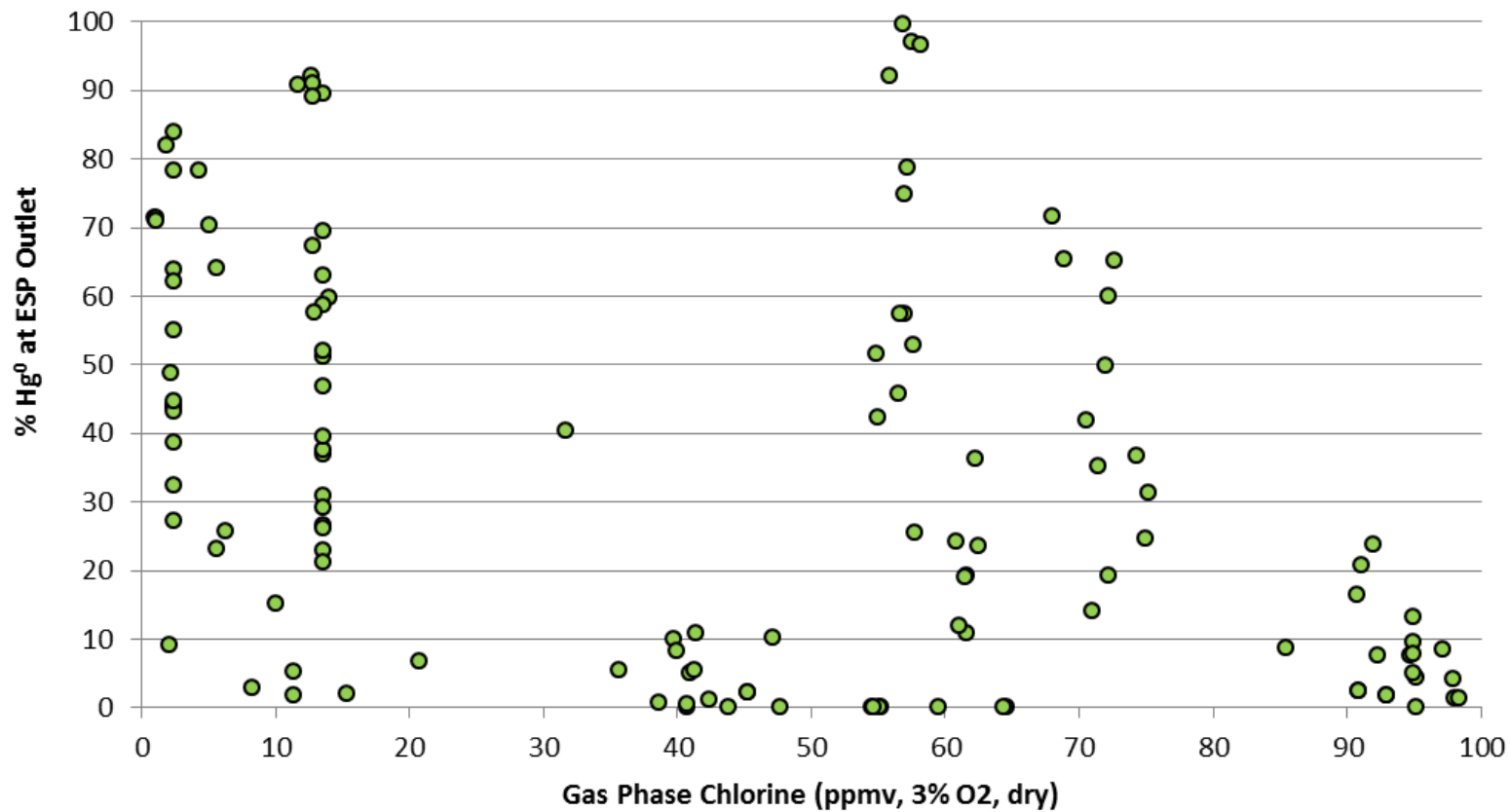
(calculated as $(\text{Hg}_{\text{in}}^0 - \text{Hg}_{\text{out}}^0) / \text{Hg}_{\text{in}}^0$ i.e. captured Hg is attributed to oxidation)



ESP Behavior



%Elemental Mercury at the ESP Outlet



ICR Data - Elemental Mercury at the ESP Outlet

Impact of Coal Chlorine on Mercury Speciation and Emission from a 100-MW Utility Boiler with Cold-Side Electrostatic Precipitators and Low-NO_x Burners

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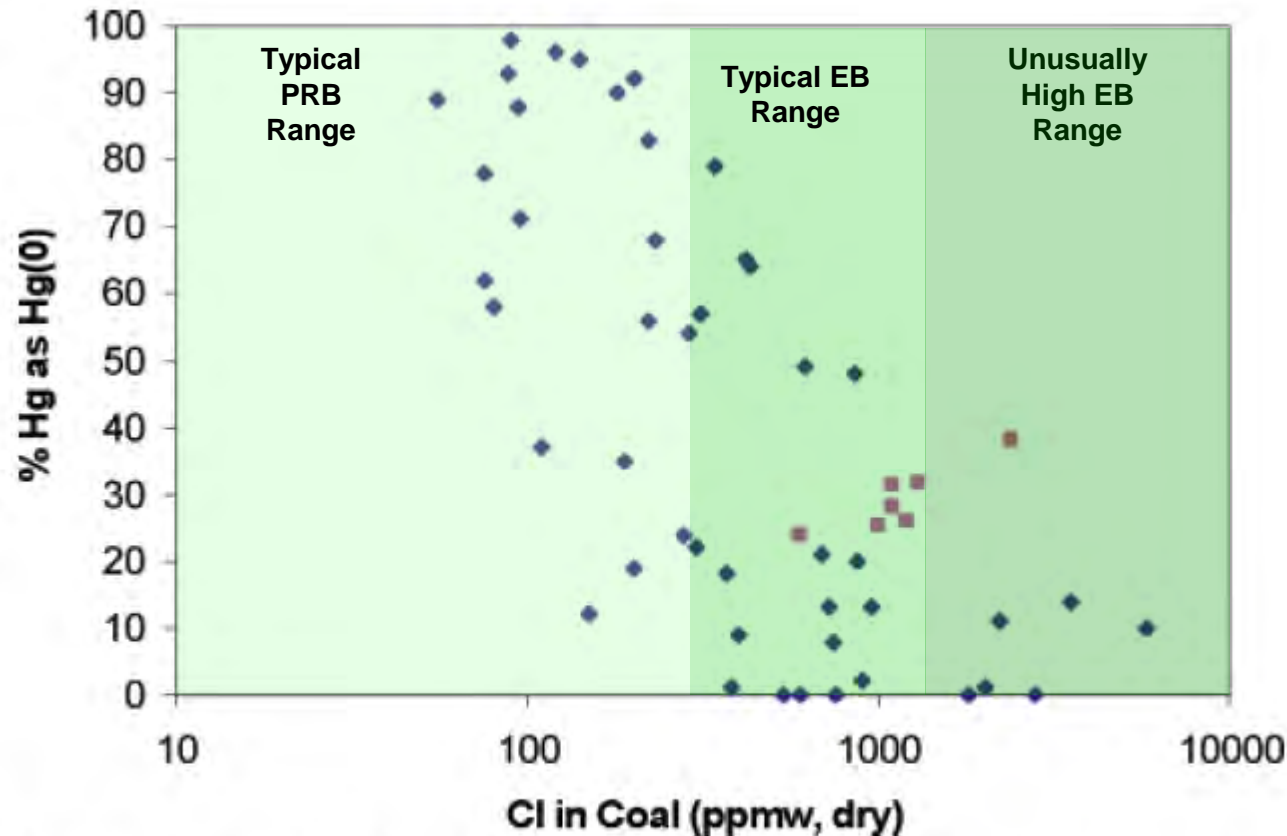
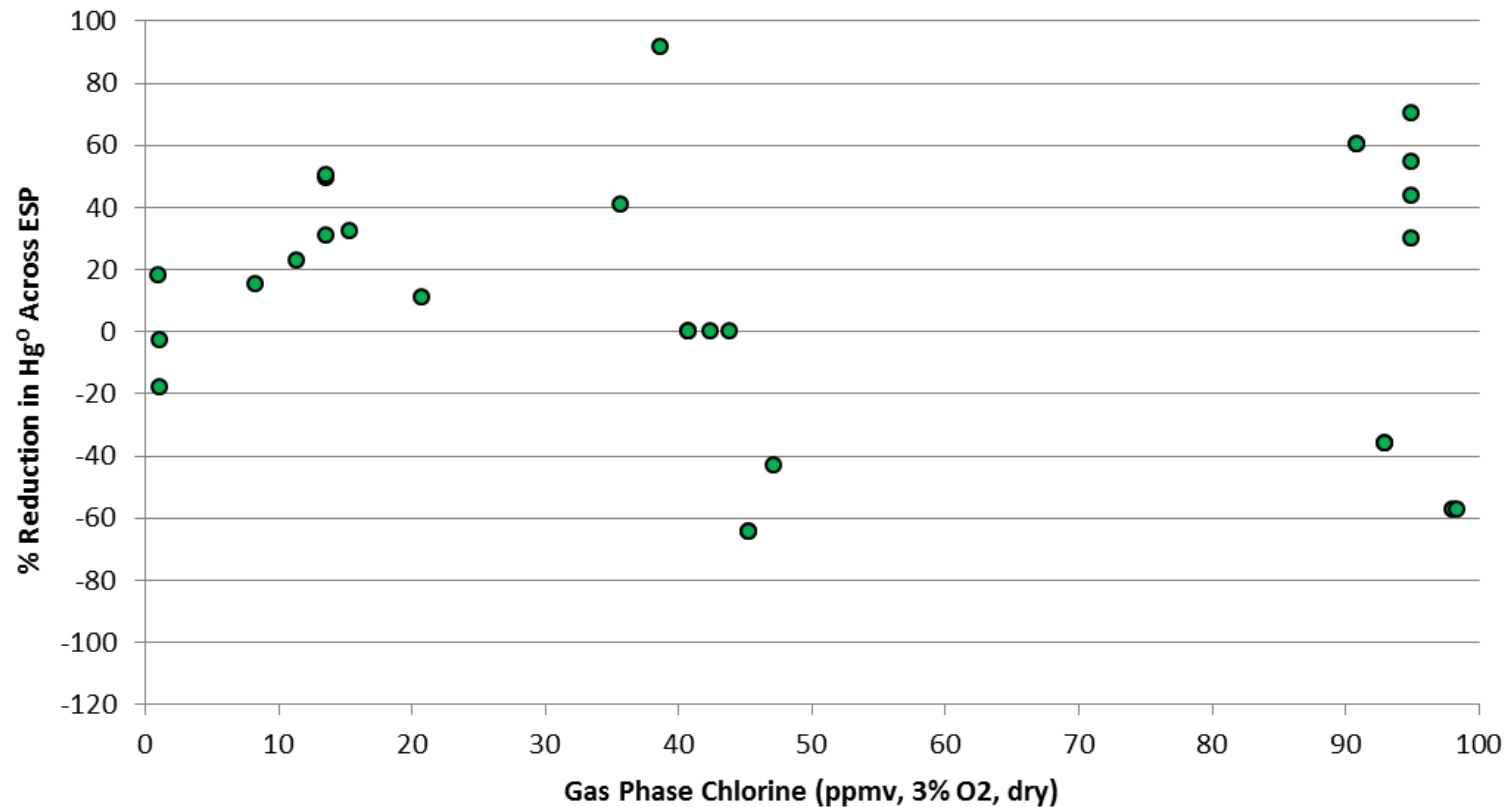
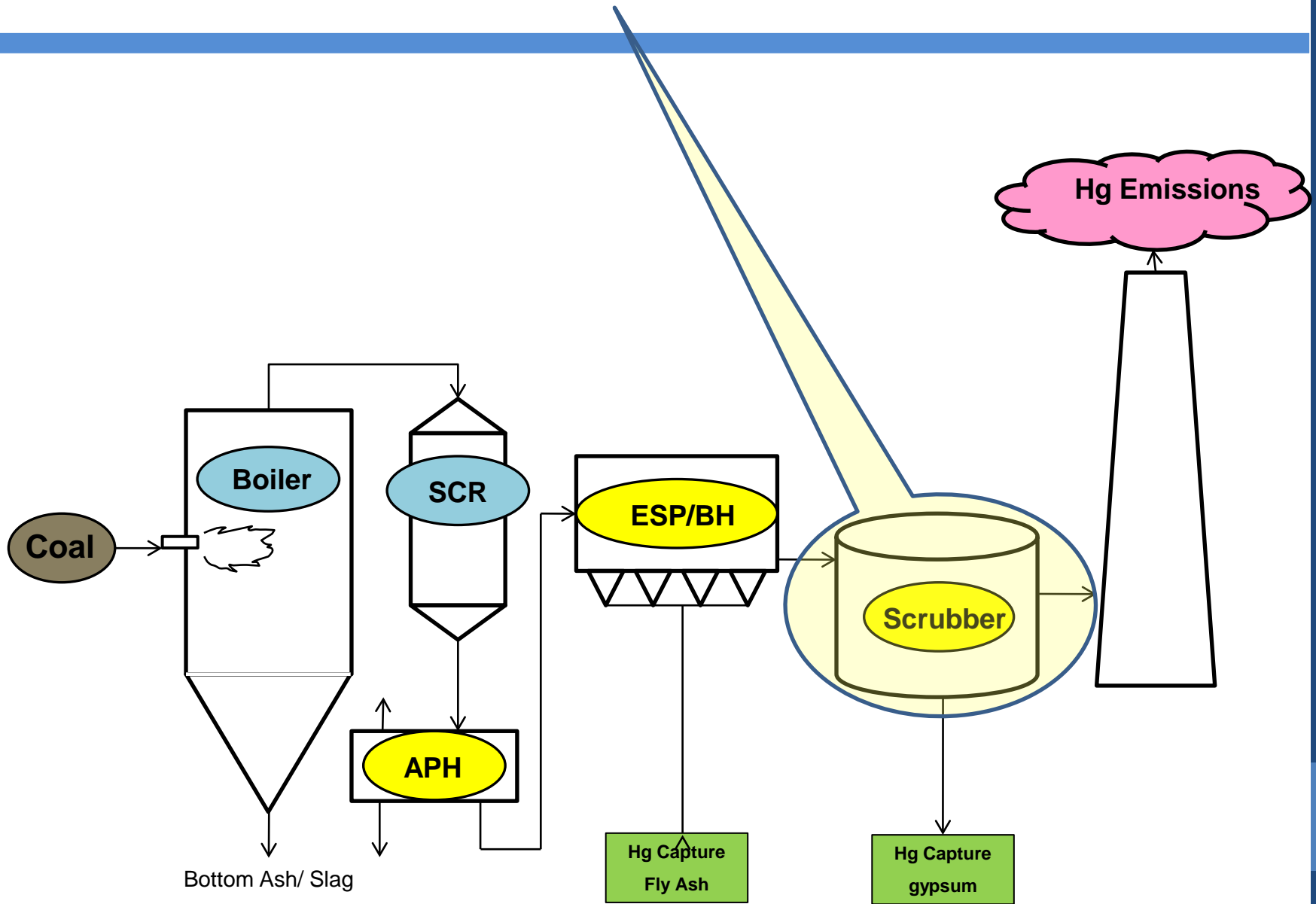


Figure 5. Effect of chlorine content in coal on gaseous mercury speciation at the ESP outlet (EPA–ICR data given in blue, WKU data given in red).

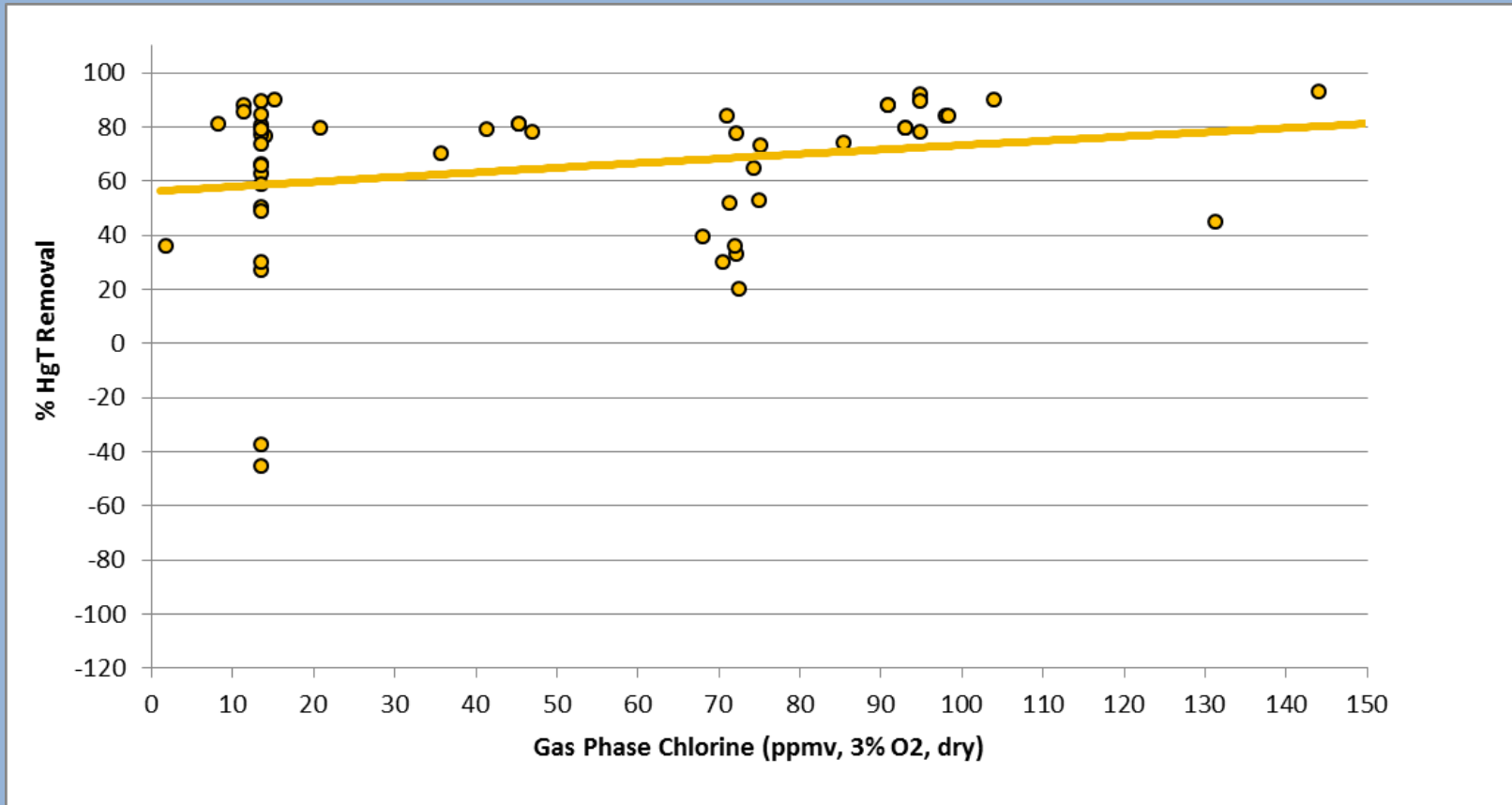
Reduction in Elemental Mercury Across ESP



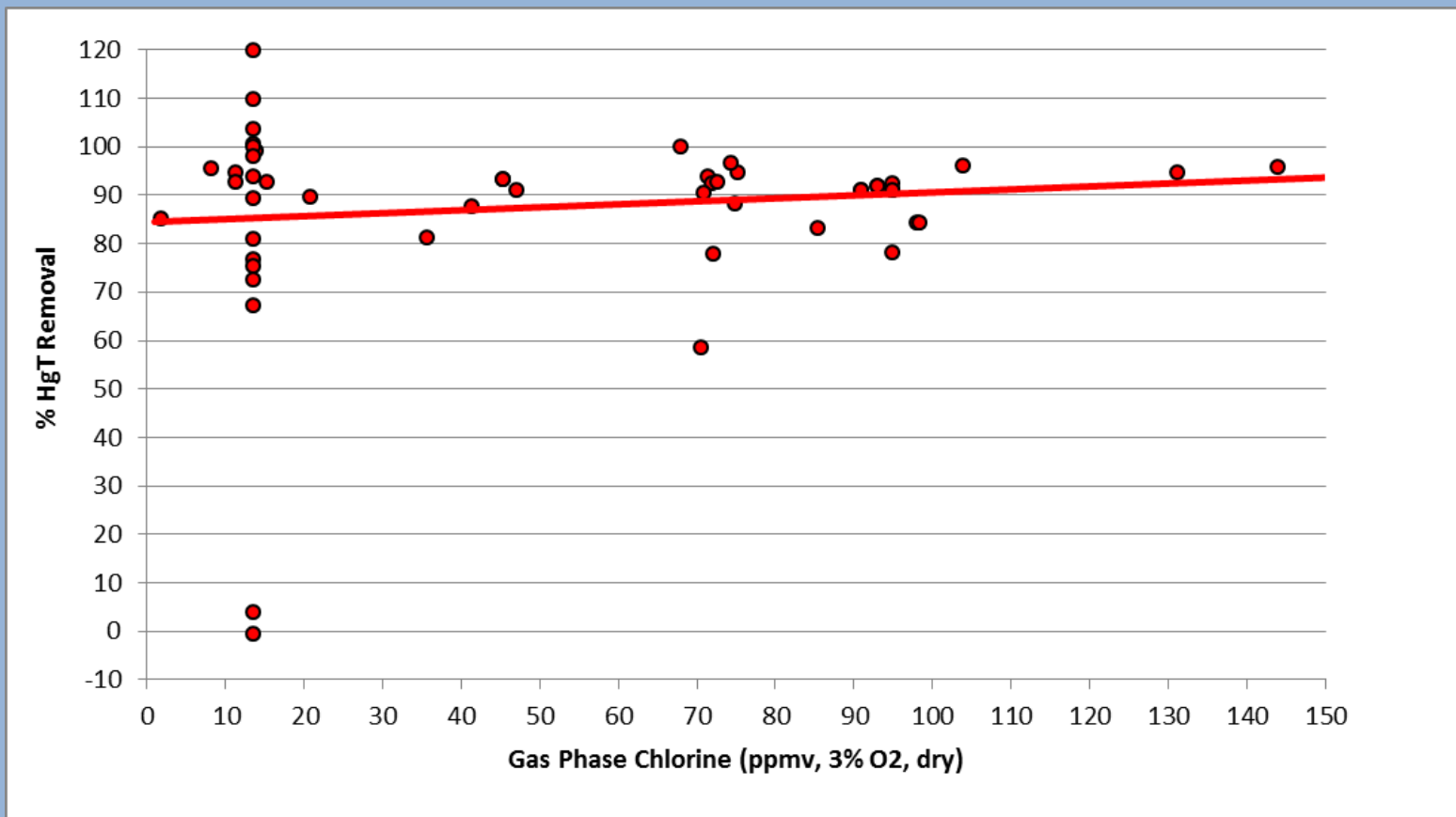
Wet Scrubber Behavior



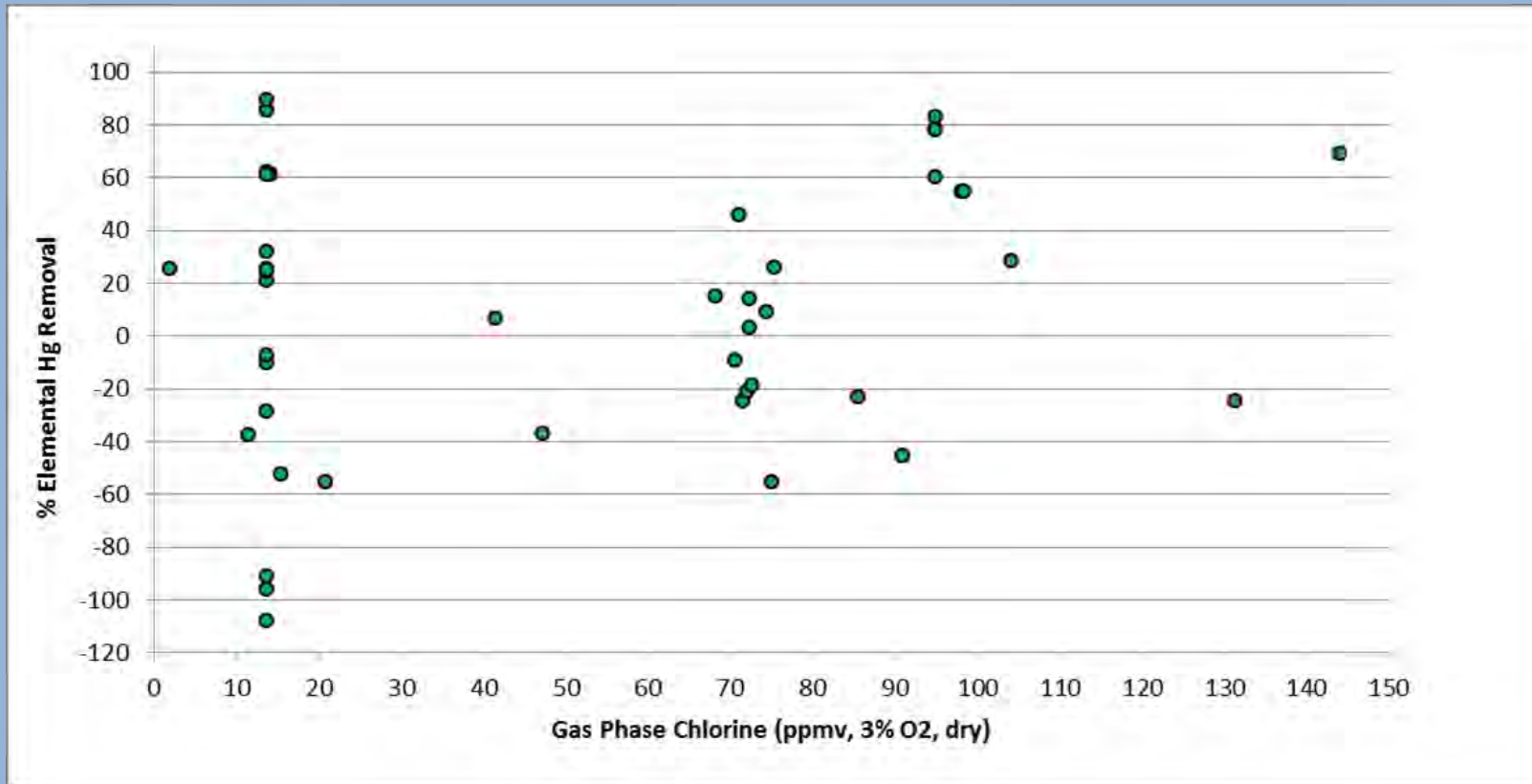
Capture of Total Mercury Across Wet Scrubber



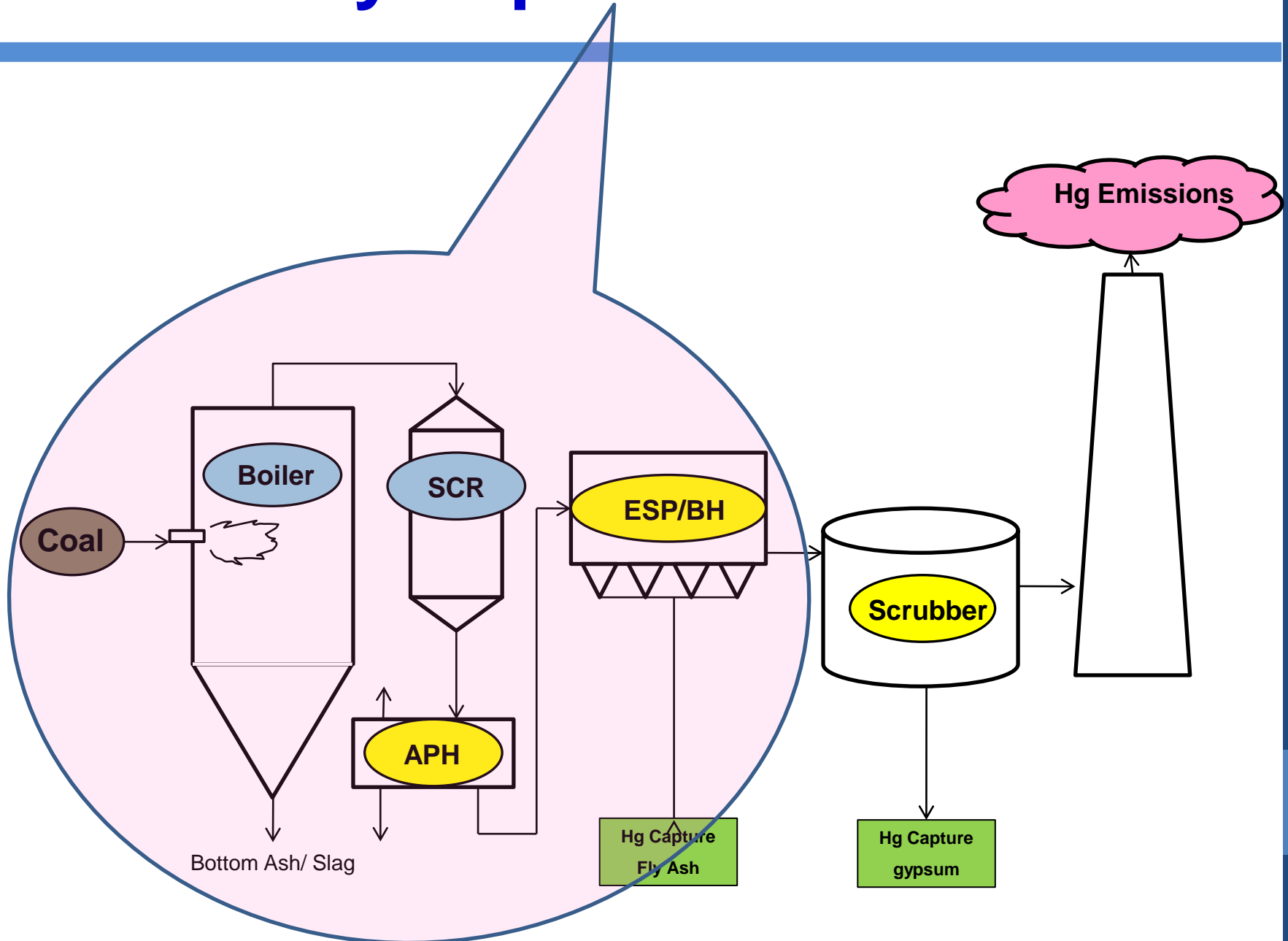
Capture of Oxidized Mercury Across Wet Scrubber



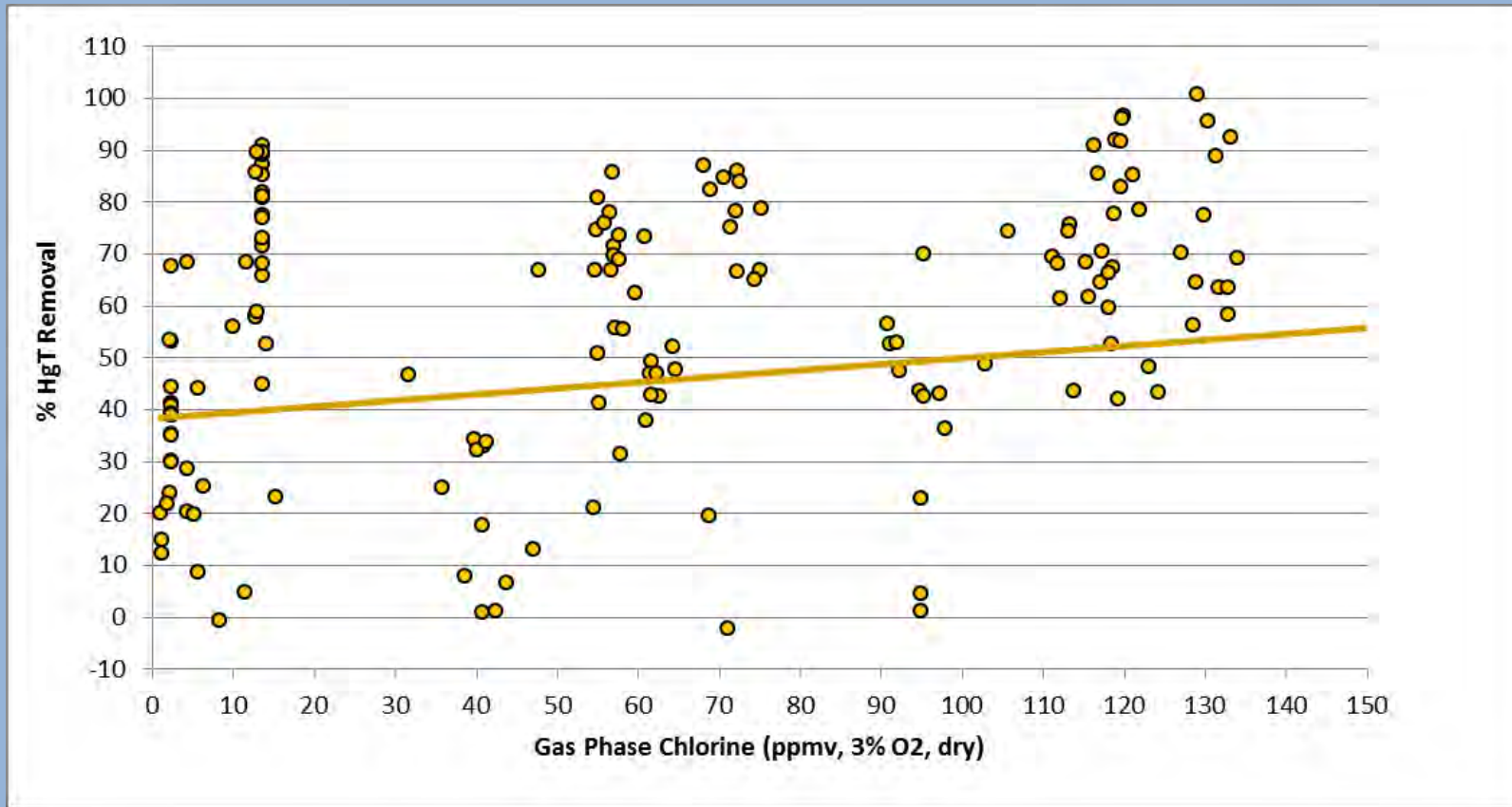
Capture of Elemental Mercury Across Wet Scrubber



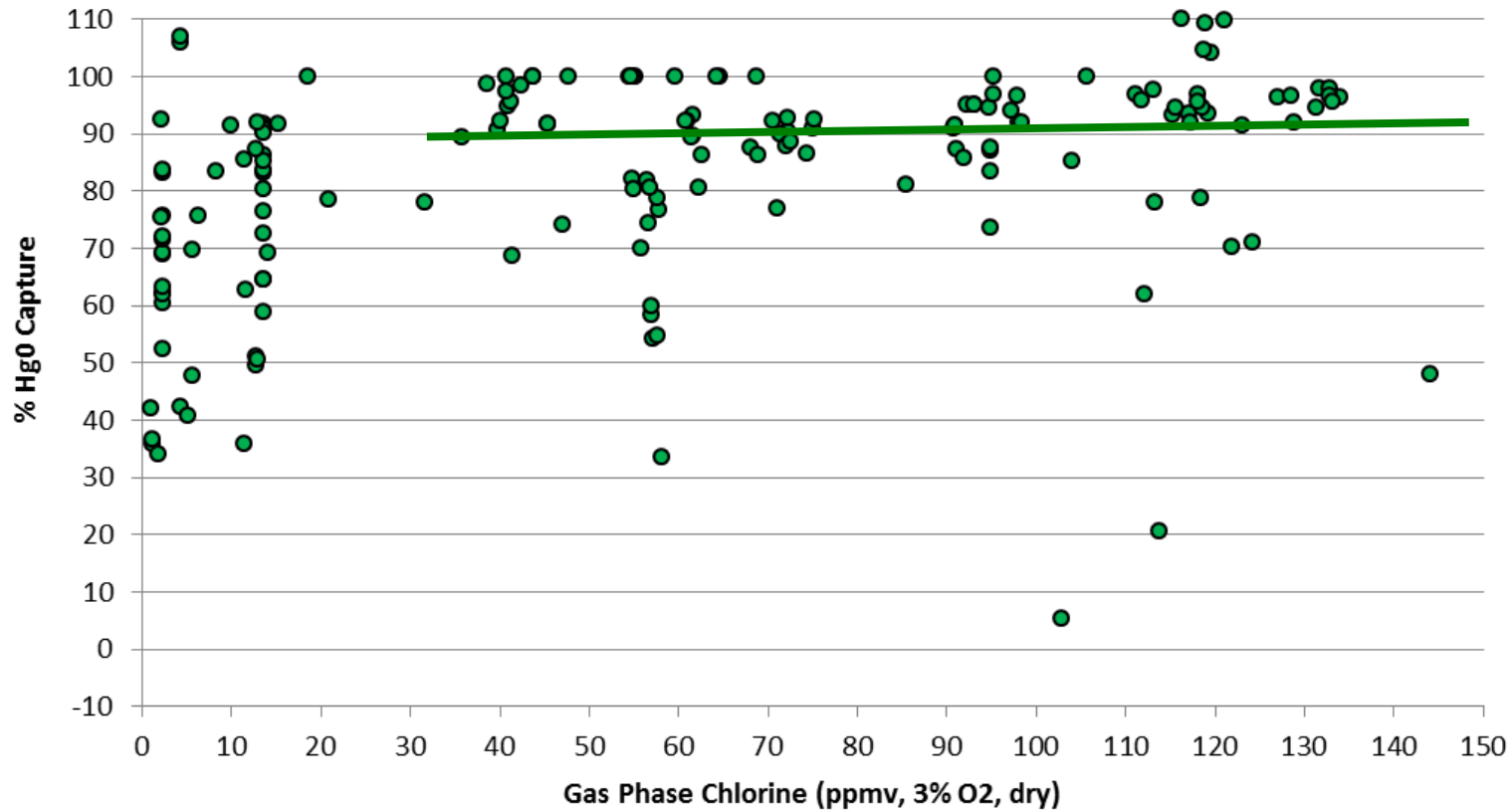
Mercury Capture at ESP Outlet



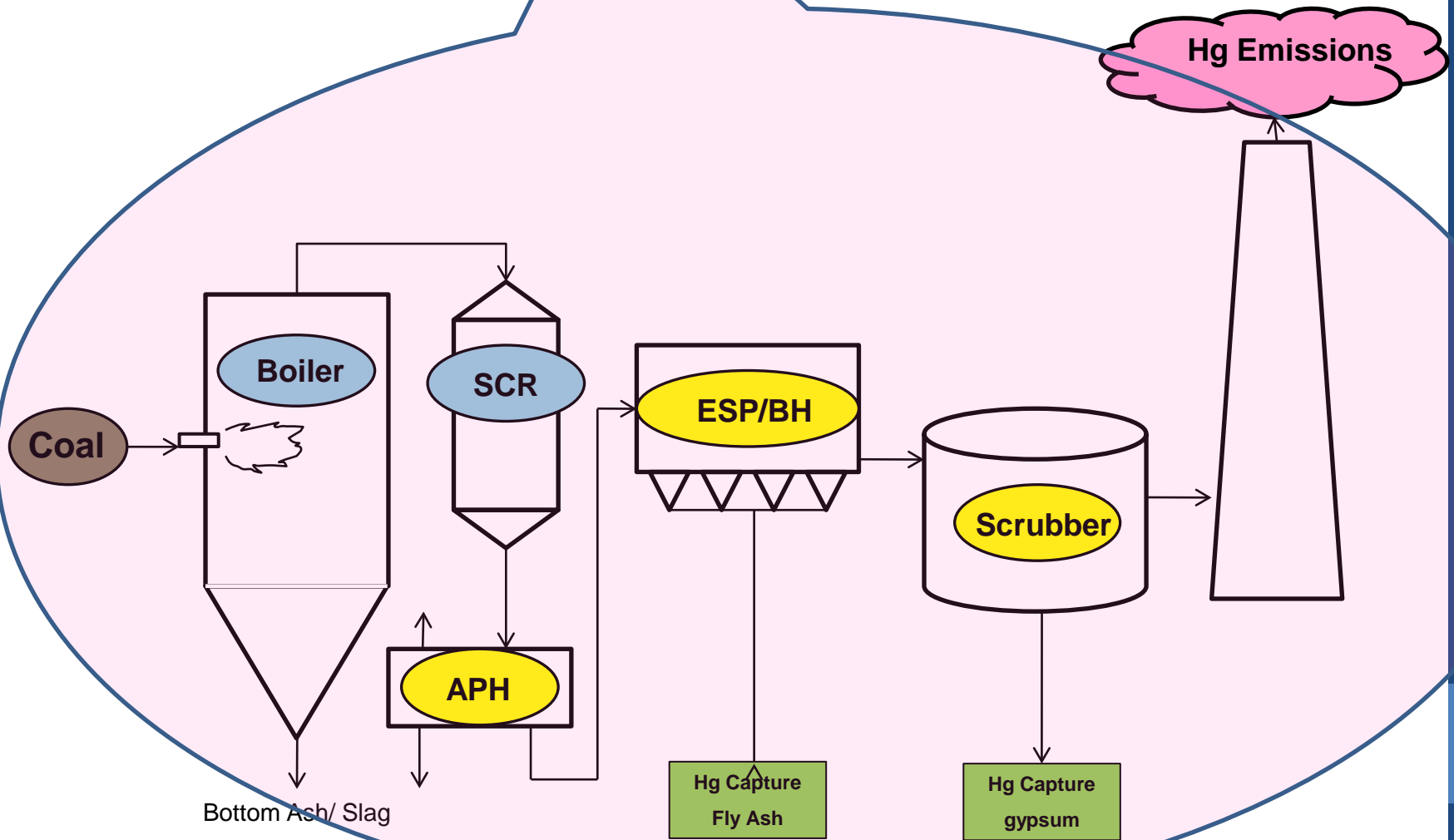
Reduction in Total Mercury: SCR Inlet to ESP Outlet



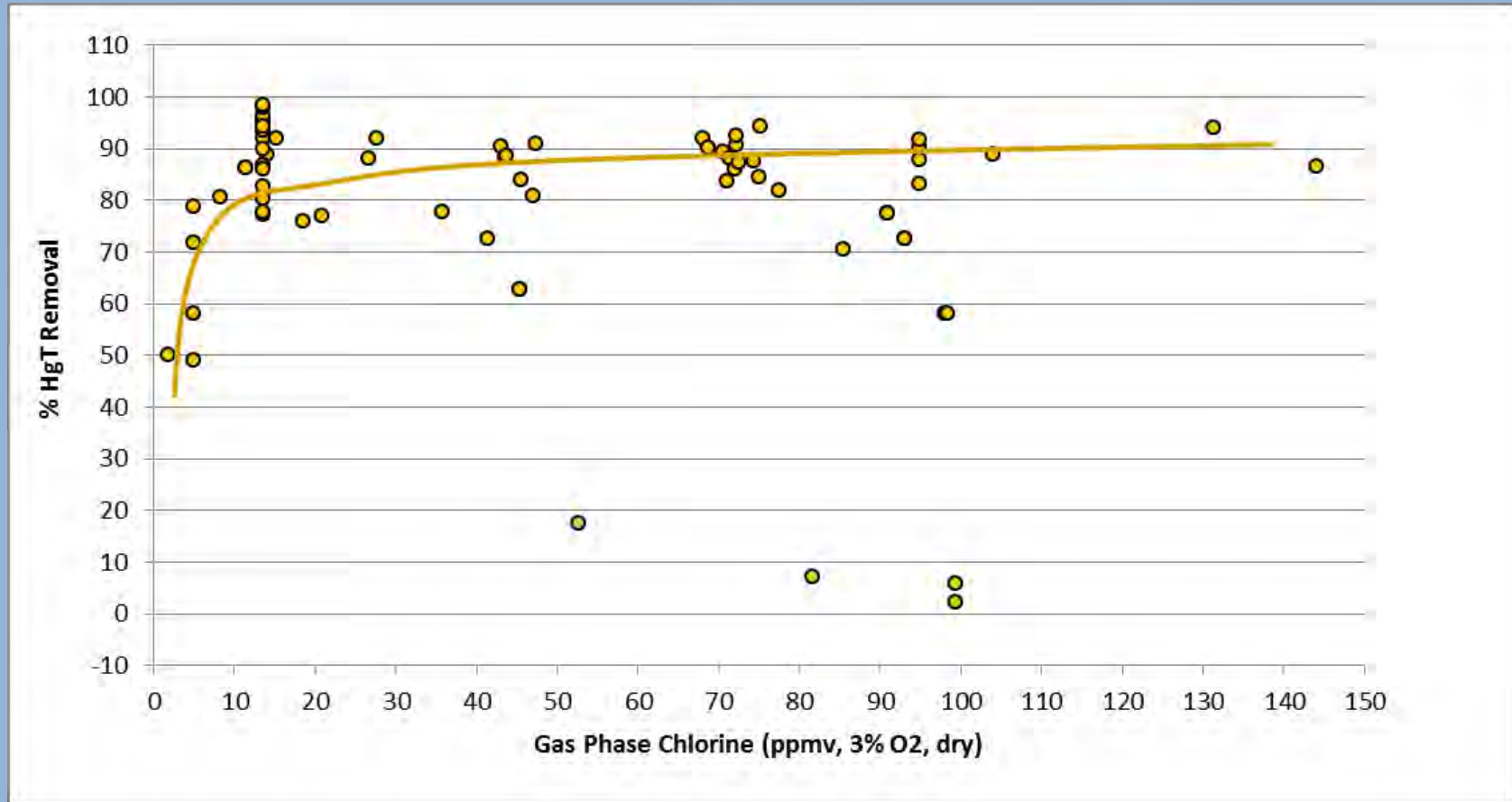
Reduction in Elemental Mercury: SCR Inlet to ESP Outlet



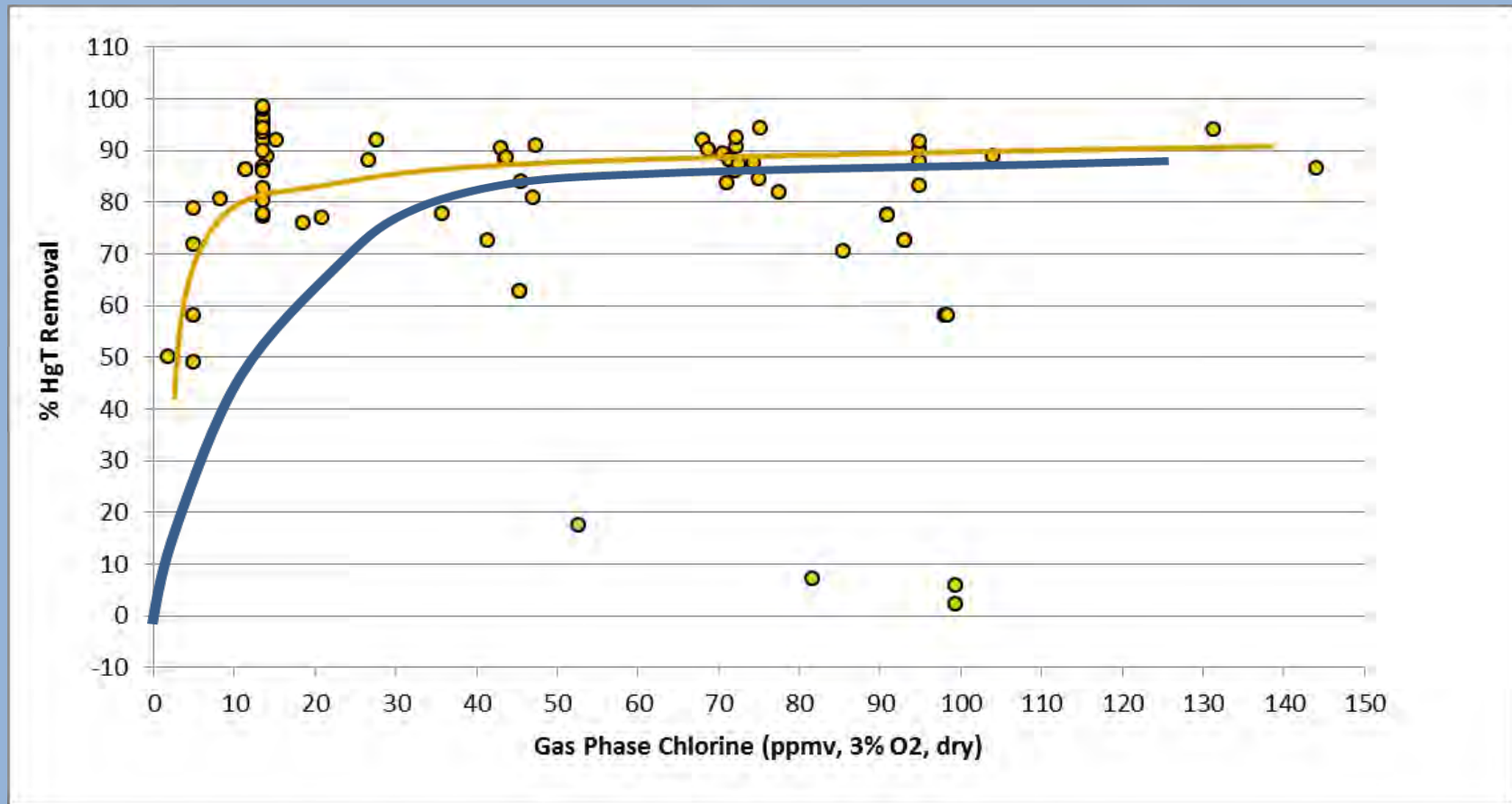
Mercury Capture at Scrubber Outlet



Capture of Total Mercury: SCR Inlet to Scrubber Outlet



Capture of Total Mercury: SCR Inlet to Scrubber Outlet



CONCLUSIONS

- Don't assume the response for single piece of equipment carries through to downstream equipment. (e.g. changes affecting the SCR do not necessarily carry through in a quantitative manner to the ESP or Scrubber outlet).
- The response for mercury oxidation and mercury capture at the ESP and Scrubber outlet may not demonstrate the same sensitivity as the SCR does to halogens and other operating conditions.
- Optimization or parametric tests should include the response parameter of interest. For instance, if you're trying to reduce emissions, measure emissions!



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