Control Options For FPI Boilers to Meet Proposed Boiler MACT Limits

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Outline

- Currently available options for control of CO, PM, HCl, Hg and PCDD/F emissions from mainly wood and combination wood-fired boilers in the forest products industry
- Problem areas where control to proposed limits might be tricky, expensive or unproven for this industry's boilers

This presentation includes some material from the following presentation(s) given at the NCASI Southern Regional Meeting in Charleston, SC (June 30, 2010)

1. *CO Emissions: Combustion Enhancements to Meet Boiler MACT Limits in Biomass-Fired Boilers* - John Le Fond, Jansen Boiler & Combustion Systems
2. *Innovative Control of Mercury Emissions from Boilers*, Michael Budin, RMT, Inc.
3. *Mercury Control Technology for the Pulp and Paper Industry,* Gordon Maller – URS Corporation
4. *Trona Injection For HCl Control and Enhanced ESP Operation*, Ray Willingham, PPC Industries
5. *MACT Case Study for a Pulp Mill Combination Boiler with ESP,* Bob Fraser, AECOM
6. *Boiler MACT Compliance with a Multi-Fuel Boiler Equipped with a Wet PM Control Device*, Frank Kalany, AMEC Earth & Environmental Services

General Facts About FPI Boilers

- Most wood products mill boilers burn mainly wood
- Among pulp mill boilers firing solid fuels, ≈100 burn mainly coal (>90% coal), ≈62 burn mainly wood (>90% wood), ≈58 burn coal with wood & ≈60 burn various combinations of wood, gas, oil and TDF
- ≈ 154 pulp mill boilers have ESPs, 23 have FFs, 15 have wet scrubbers, 77 have venturi scrubbers, 9 have wet ESPs, and 37 have only mechanical collectors
- Of the pulp mill boilers, 93 are of pulverized coal type, 7 are cyclones, 171 are stokers, 11 are underfeed stokers, 10 are fluidized beds & 10 are dutch ovens

Options for CO Compliance

- Combustion system upgrades / modifications
- Post combustion control with CO catalyst
  - Catalyst section upstream of PM control device if no biomass fired
  - Downstream of wet scrubber/precipitator difficult because of low temperatures and saturated flue gas - reheat required

Combustion system upgrades / modifications

- Perform evaluation of current conditions, including emissions characterization and CFD analysis
- Optimize combustion performance
  - improve mixing, increase combustion temperature
- Upgrade overfire air system
  - Could be difficult in stoker-fired boilers with high grate and volumetric heat loadings, and high moisture fuel

Combustion system upgrades / modifications

- Difficult to meet lower 'stoker coal-fired' emission limits (50 ppm) with combination coal & wood boilers (>10% heat input from coal)
- Fuel variability and load fluctuations introduce uncertainties in meeting limits at all times

General Recommendations for Evaluating **CO** Control Options

- Operate boiler long term with CO CEMS (rental) to understand variability
- Check simultaneous requirements for NOx
- If burning coal, understand the impact of burning >10% coal and sharply lower CO limit of 30 to 90 ppm @3% O_2

Options for PM Compliance
Combination Boiler With Wet PM APCD

- Have wet scrubber - increase pressure drop to improve particulate removal ???
  - New ID Fan or Tip ID Fan
  - Add booster fan
- Have wet scrubber - add wet ESP after scrubber
- Have wet ESP – to comply with Boiler MACT
  - Repair/Upgrade
  - Convert to Dry ESP
  - Add Baghouse for enhanced reagent or ACI

Options for PM Compliance
Combination Boiler With Dry PM APCD

Replace the Current Device

- Pros
  - Single New Installation with Performance Guarantees
  - Long Expected Life…
- Cons
  - Tight space adjacent to existing ESP
  - Mill staff uncomfortable with replacement FF or ESP "box" conversion to FF (concerns with FF operations)
  - ESP recently rebuilt at considerable cost

Options for PM Compliance
Combination Boiler With Dry PM APCD

Add to Current Device

- Add On Options
  - Polishing Two Field ESP
  - Polishing Fabric Filter
  - Polishing WESP

Options for PM Compliance
Combination Boiler With Dry PM APCD

- Pros to adding to current device
  - Staged collection enables separate collection of clean ash and any injected sorbents
  - More flexibility for installation of future SCR catalyst
  - Separately collected sorbents may be re-injected to reduce sorbent cost
  - Smaller space requirements, 4 week outage tie in
- Cons to adding to current device
  - Reliance on very old existing Primary ESP
  - Hot ESP would afford better future oxidation catalyst and/or SCR flexibility

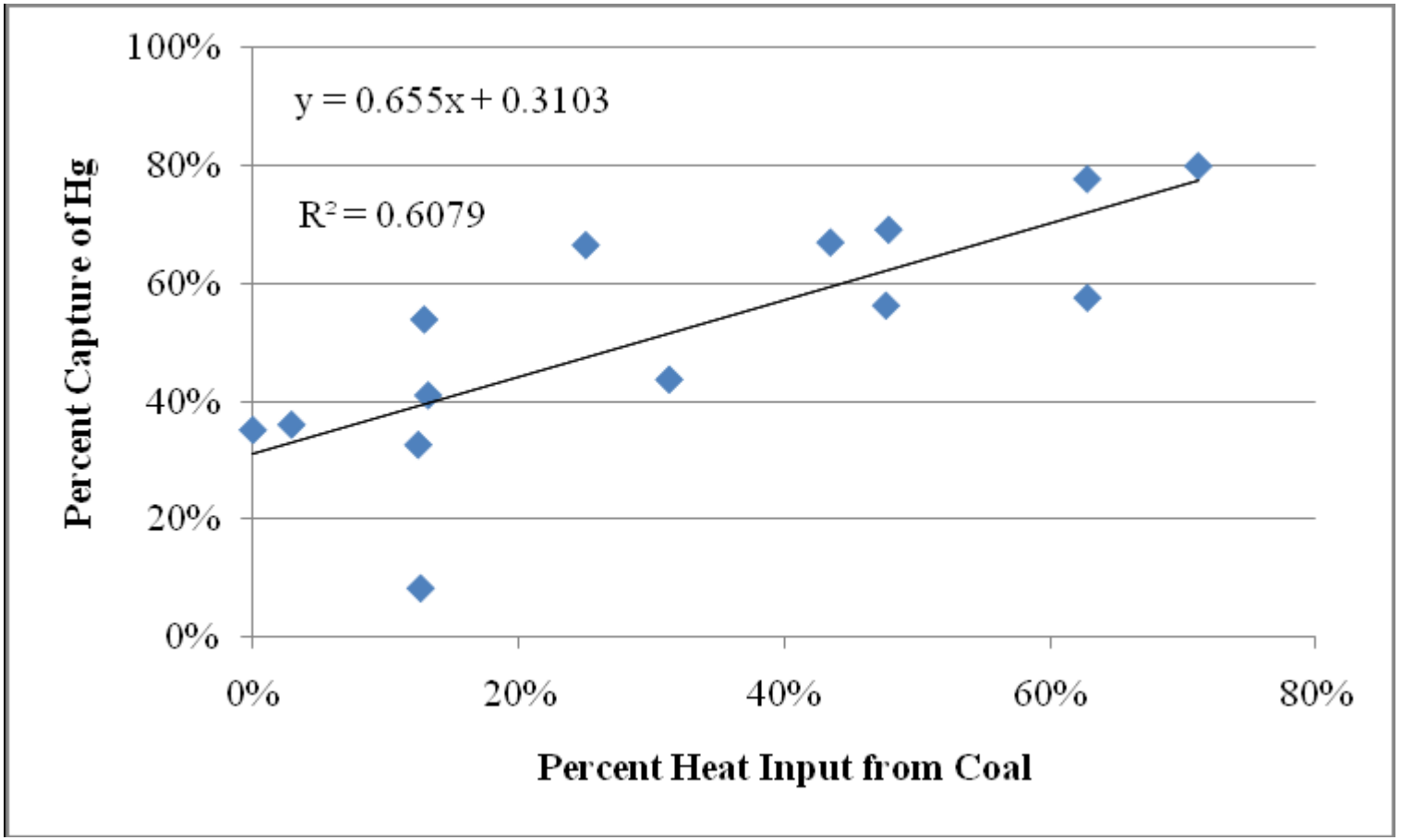
Options for Hg Compliance

- Mercury chemistry is very complex
- Hg in flue gas can exist as elemental (Hg^0), oxidized (Hg^{2+}) or particulate (Hg–P)
- Chemistry is governed by changes in temperature, residence time, concentration of competing species, chemical form of mercury in the fuel, etc.
- Chemistry dictates the control technology/ technologies

Options for Hg Compliance
Combination Boiler With Wet PM APCD

- Wet particulate scrubber or wet ESP with ACI will remove some mercury - however typically < 50% removal expected
- Improved removal with the presence of HCl
- Improved removal with Halogen-impregnated carbon

IMPACT OF VARYING MERCURY INPUT IN A BIOMASS BOILER – NCASI STUDY



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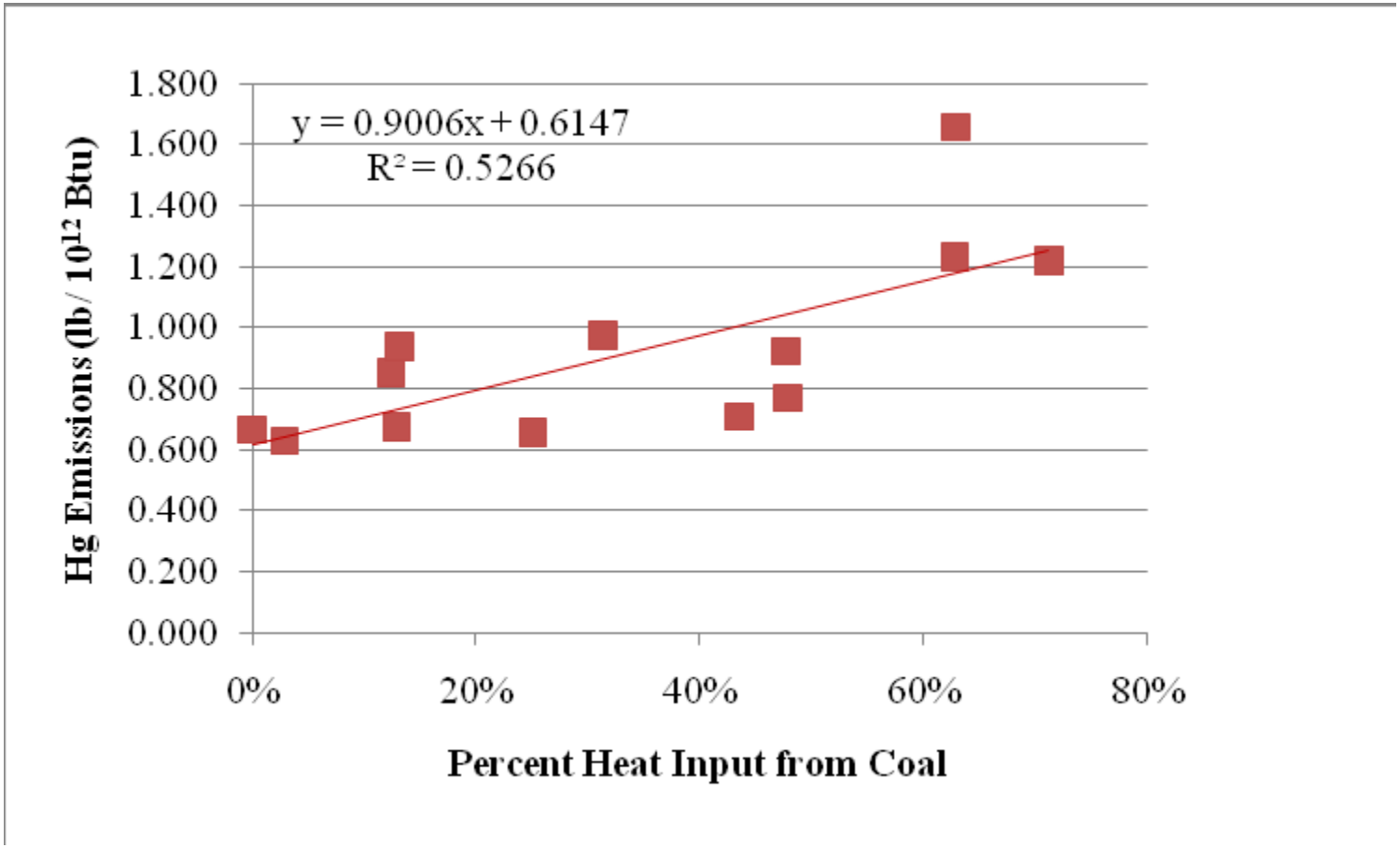

IMPACT OF VARYING MERCURY INPUT IN A BIOMASS BOILER – NCASI STUDY

Results

- Mercury emissions varied considerably from test to test and ranged from 0.66 to 1.37 lb/10^{12} Btu
- Mercury capture efficiency varied significantly ranging from 8 to 80% for different test runs
- Mercury input to the boiler varied from 0.98 to 6.14 lb/10^{12} Btu and was significantly affected by the fuel mix due to the higher mercury content of coal

Options for Hg Compliance
Combination Boiler With Dry PM APCD

- ACI Upstream of Secondary Collector
  - ≈ 90% Hg Capture Possible with FF - Same Control Used by MWCs
  - ACI + ESP Also Capable of High levels of Control
- WESP Capture Less Well Understood
- Best removal is ACI with Baghouse

Process Control Options for Hg Compliance
Emerging Technologies

- Combustion Controls
  - Fuel Additives (KNX™ Additive; MercPlus™)
- Sorbent Injection
  - Minerals, PAC, BPAC
- Furnace Injection
  - mineral sorbent injected directly into furnace
- Fixed Structures
  - Honeycombs, woven screens, plates

Collateral Reduction of Hg Emissions With Increased PM Collection

- Reduction due to
  - increased capture of carbonaceous wood ash
  - more residence time in second ESP
  - filter cake on bags, improved contact
  - condensation and capture in wet ESP (not well understood)

Summary Recommendations for Hg Control Options

- Understand in what form mercury exists in the boiler exhaust - testing
- Select appropriate control technology
- Consider the impact of disposing of mercury in the fly ash from the boiler

Options for PCDD/F Compliance

Boiler Operating Conditions That May Result in Maximum **PCDD/F** Formation

- Fuel mix with the lowest ratio of S to Cl
- Firing of the poorest "quality" fuel (highest moisture, lowest Btu content, highest ash)
- Firing of fuels with the highest metal content, especially Cu
- Oscillating load conditions that lead to the most transient combustion conditions
- PM control device operation with the least effective PM capture, especially $PM_{2.5}$ capture

Options for PCDD/F Compliance

- ACI Upstream of Secondary Collector
  - ACI + FF - control sequence used by MWCs
  - ACI + ESP - also capable of high levels of control
- WESP Capture Less Well Understood
- Formation may be mitigated by increasing the S to Cl ratio in combined fuel
- Collateral Reduction with Increased PM Collection

Options for HCl Compliance
Combination Boiler With Wet PM APCD

- Wet scrubbers should generally be able to meet the limit
- In the case of a wet ESP, if limit is not met, then trona injection may be investigated

Options for HCl Compliance

Combination Boiler With Dry PM APCD

- Collateral Reduction with Increased PM Collection?
  - more residence time in second ESP - reaction with alkaline wood ash
  - improved contact with filter cake on bags
- Dry Sorbent Injection Upstream of Dry Secondary Collector
  - Trona, Lime, Sodium Bicarbonate, etc.

Key Outstanding Issues with Control Options for Meeting Boiler MACT CO Limits

- Proposed limits (PL) of 50, 30 and 90 ppm for stokers, FBCs & PCs burning coal (>10%) appear impossible to achieve
- PL of 560 ppm @ 3% O_2 for stokers burning biomass (<10% coal) is likely to be racheted down considerably
- Current PL for biomass stokers may be achievable under steady loads and fuel firing conditions; not sure for constantly fluctuating loads and varying fuel quality
- Unachievable if extremely high concentrations (albeit with low mass emissions) are measured during startup/ shutdown and have to be included in the 30-day average

Key Outstanding Issues with Control Options for Meeting Boiler MACT PM Limits

- To meet the PL of 0.02 lb/10^6 Btu (24 hr avg), boilers with wet scrubbers (WS) will need to add wet ESPs or replace the WS with dry ESP, FF or a "super" WS
- EPA's recommendation to use PM CEMS on boilers (>250 MMBtu/hr) to demonstrate continuous compliance could be problematic, especially since SSM conditions would be included and the performance of PM CEMS has not been demonstrated on biomass or multi-fuel units
- Also, it is unclear whether load swings would be a consideration, given the 24 hr averaging time

Key Outstanding Issues with Control Options for Meeting Boiler MACT Hg Limits

- Traditional technologies such as ACI with FF too expensive and also unproven on combination biomass boilers
- Lot of unanswered questions including
  - Form of Hg in biomass boiler stack emissions
  - Role of varying fuel Cl and S in altering this form
  - “Emerging” Hg control technologies and biomass boilers

Key Outstanding Issues with Control Options for Meeting Boiler MACT Limits

- HCl
  - Consistent capture below 0.006 lb/MMBtu using sorbent injection in boilers with dry PM APCDs not yet proven
- PCDD/Fs
  - Likely the most complicated pollutant to consistently control below PL of 0.004 ng TEQ/dscm for stokers
  - Only general guidelines available for minimization of generation during combustion
  - Very limited experience with post-combustion control using ACI or other relevant technologies