NLA Mercury Project

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Lime Industry Hg Emissions

- Virtually all TRI Submissions Based on EPA/NLA Emission Factor:
  - 15 lbs Hg/MM tons lime
  - Based on tests of 4 kilns (2 plants):
    - Baghouse equipped preheater & vertical,
    - Scrubber-equipped straight kilns
  - Few Lime plants TRI reports > 25 lbs
- But, Limestone on the Defense

Factors Distinguishing Cement from Lime

- Lime Plants not Located in Geological Belt with History of Geothermal Activity
- Larger Stone Feed
- Lower Operating Temperatures
- Primarily Baghouses
  - Longer Residence Time than ESPs
- Kiln Dust not Reintroduced to Kiln

Project to Start Characterizing Hg Emissions

- EMI Prepared Hg Sampling/Stack Testing Plan
  - Opportunity to Determine Oxidized vs Elemental Portions of Hg
- Test Drive at Western Lime's Eden Plant
  - Preheater & straight kiln
  - Kilns burn same dolo stone & same fuel (coal)
- Platt Environmental Retained to Conduct Test
  - EMI test observer

Protocol Overview

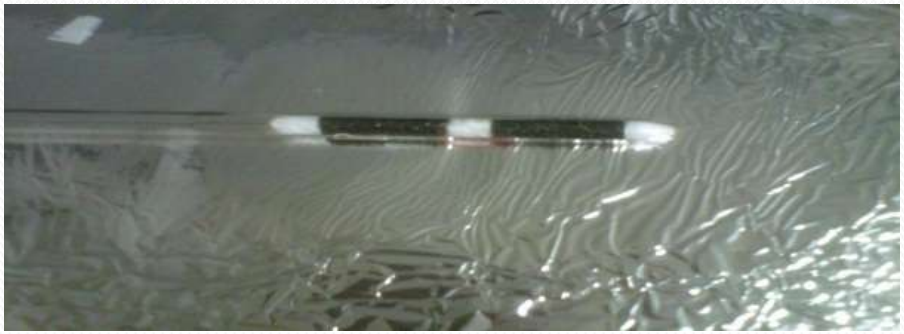
- Two Components
  - Solids Sampling & Analysis
  - Stack Testing
- Both Components use Ohio Lumex Analyzer
  - Thermal Desorption followed by AA for Hg
- Previous Lime Industry Analyses used Acid Digestion

Solids Sampling

- Four Weeks Preceeding Stack Test
  - WLC collected daily one pound samples of stone, LKD, coal and lime
  - Representativeness is important, esp. LKD & fuel
  - Samples ground w/ hammer mill to ¼ inch
  - Weekly composites
- One Week before Stack Test
  - Sent one weekly composite of stone , LKD, lime & coal to Platt to select suitable concentration of spiked traps

Stack Testing

- EPA Method 30B (Sorbent Trap Method)
  - Six one-hour runs
  - Paired runs



- Concurrent Paired Speciated Testing

Solids Sampling Hg Results

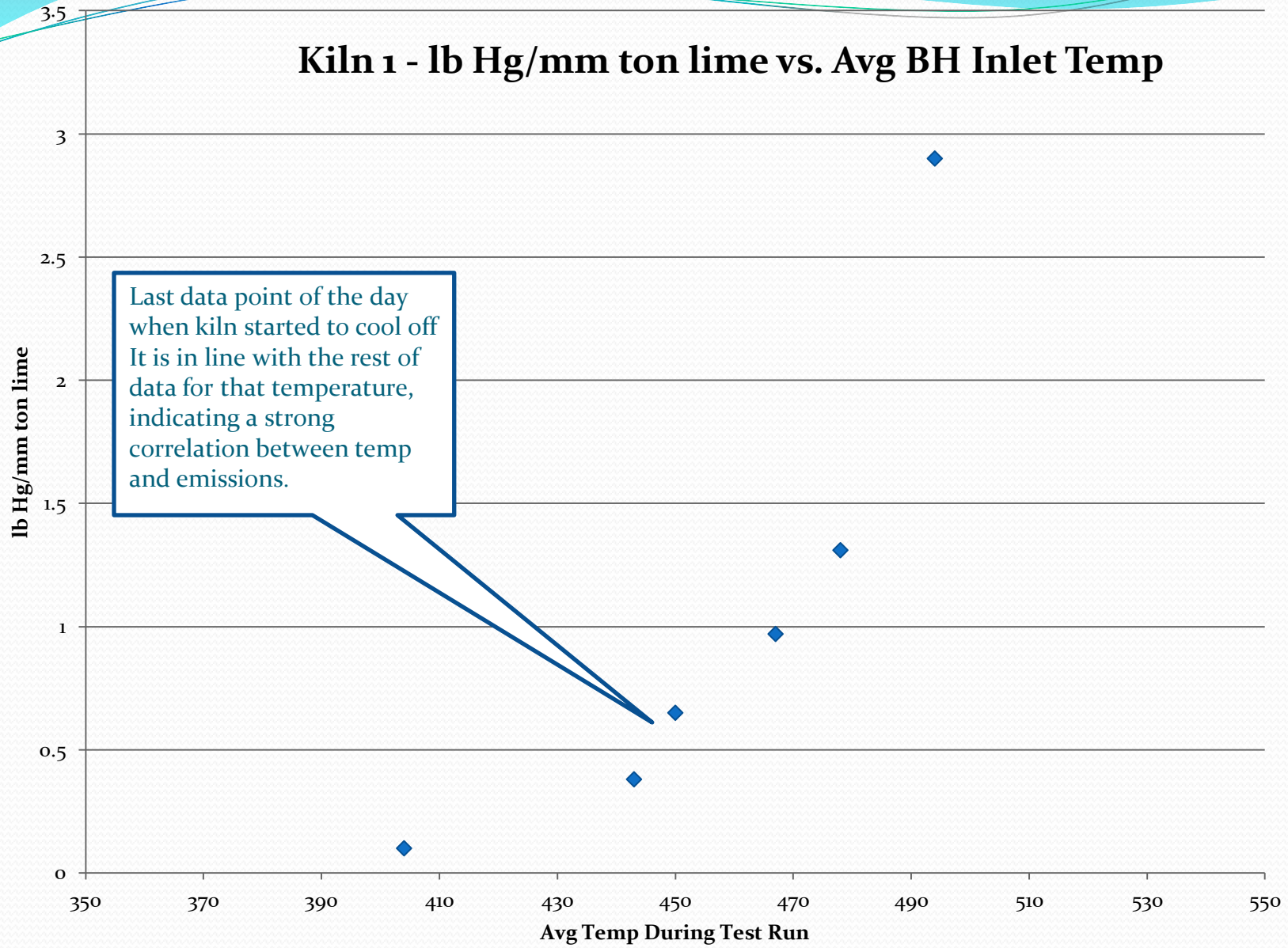
	Average (ppb)	2 Sigma
Stone	0.93	0.3
Lime	0.32	0.4
Coal	34.2	13.2

LKD Sampling Hg Results

	Average (ppb)	2 Sigma
Straight Kiln		
Pre-test	138	19.3
Test day	58	NA
Preheater Kiln		
Pre-test	22.6	3.1
Test day	19.5	NA

Kiln 1 Stack Test Results

- Straight kiln w/ external heat exchanger
- Hg emitted a function of weather conditions and heat exchanger
  - Cooler inlet to FF = < Hg emitted (next slide)
- Hg retained by system 85% and greater.
  - Less than 3 lb/MM ton lime


Kiln 1 - lb Hg/mm ton lime vs. Avg BH Inlet Temp
lb Hg/mm ton lime
3.5
3
2.5
2
1.5
1
0.5
0
350
370
390
410
430
450
470
490
510
530
550
Avg Temp During Test Run
Last data point of the day when kiln started to cool off It is in line with the rest of data for that temperature, indicating a strong correlation between temp and emissions.

Kiln 2 Stack Test Results

- Pre-heater kiln
- Hg retained by system 10% or less:
  - 12-15 lb/MM tons lime
- No gases vented from pre-heater directly to BH
- Baghouse inlet temp steady & much lower than straight rotary (next slide)

Baghouse System Characteristics

	Air-to-Cloth Ratio	Inlet Temp (deg. F)	Bag Type
Kiln 1: Straight w/ U-tube Heat Exchanger	1:1 Reverse Air	400 - 494	Fiberglass
Kiln 2: Pre-heater	4:1 Pulse Jet	354 - 364	Membrane

Baghouse Inlet Temperature

- Theory: Lower temperature = more Hg adsorption by LKD
- Observation
  - K1 Hg concentration correlated with BH inlet temp
  - But, K2 inlet temp much lower than kiln 1, and emissions greater than 10 times higher
- Alternate explanation re K1:
  - U-tube acted as Hg sink

LKD Quantity & Composition

	Historic LKD Generation Rate	Unburned Carbon in LKD on April 26-27		Hg in LKD
		%	lb/hr*	ppb (avg)
Straight Kiln	6 to 9%	0.45	7.6	58
Pre-heater Kiln	4 to 4.5%	0.03	0.5	19.5

* Based on 7.5% and 4% LKD generation rate for kilns 1 & 2 respectively

LKD's Role on April 26-27

- Theory: Greater unburned carbon = greater Hg adsorption
- Compared to Kiln 2, the straight kiln had:
  - Twice LKD generation rate
  - 15 times more unburned carbon generated
  - 3 times higher conc. of Hg in the LKD
- Also, straight kiln's residence time twice the pre-heaters kilns

Major Findings

- More than 80% of Hg is elemental
  - both kilns
- Stone type (dolo vs hi-cal) not a factor
- Coal primary source of Hg
  - at least at this site
- Stone's (& lime's) Hg content is negligible
- Less Hg in LKD = More Hg to atmosphere

Unresolved

- Whether the difference in Hg emissions from the two kiln systems is a result of
  - The heat exchanger upfront of the straight kiln
  - The difference in baghouse systems (type & filter media)
  - The difference in LKD generation rate & unburned carbon content

Lessons Learned re: Solids Sampling

- Preferred approach: off-site analysis of pre-test solids samples
- Coffee grinder can reduce ¼ inch samples to 50 mesh
  - Beware of potential cross contamination of sample types
- Confirmed importance of sequencing solids sampling

More Lessons

- One pound samples needed even though only 100 g needed for Hg analysis
  - Labs require one pound for carbon & chlorine analysis
- Stack testers should bring several ranges of spiked Hg traps to allow for variability in stack concentrations

Protocol Streamlined

- Three (not 6) paired runs, unless first 3 runs highly variable
  - Important to have decision-maker on-site to evaluate real-time results & whether additional runs warranted
- Single (not paired) speciated runs
- Analysis of solids added
  - Unburned Carbon: LKD
  - Chlorine: Stone & fuel

Proposed Next Steps

- This summer, lime MACT major sources to conduct solids sampling component of protocol
  - NLA solids sampling rate available
- Solids sampling instructive regarding:
  - Hg loading to the kilns
  - Hg retention (in LKD)
- Above data useful to identify kilns where stack sampling may be warranted

Next steps (cont'd)

- Stack testing component of protocol suitable for dry APCDs with single stacks
  - If solids sampling results from scrubber & monovent-equipped kilns indicate potential for relatively high emissions, the protocol will be tailored to address these kilns.