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The Relationship Between Particulate & Mercury Control

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Background on AEP Testing

- Phase 1 Testing program started before proposed MATS rule was issued
  - Looked at stack levels of particulate matter, mercury and acid gases
  - Compared different Method 5 filters & temperatures (quartz vs. glass fiber, 250°F vs. 325°F)
- Phase 2 testing program started after issuance of final MATS rule. Focus on:
  - Stack levels of mercury and particulate matter
  - Mercury speciation across gas path, mercury removal rate across FGD and what drives it
  - Particulate removal across FGD and what affects it
  - Mercury re-emission

Testing Summary

- Early Phase 2 testing program - look at whether higher PM levels into the FGD affected the FGD's PM removal efficiency
- Noticed a correlation between high PM levels into FGD and high(er) mercury at the stack
- Decided to evaluate this in addition to looking at different FGD operating conditions
- Most Phase 2 testing considered mercury & particulate matter at inlet/outlet of FGD
  - Varying loads
  - Varying FGD operation – L/G, oxidation air rate, pH
  - ESP detuning

Unit "A" Characteristics

- 1320 MWg unit
- SCR - four layers of plate type catalyst
- 6 ESPs, 400 SCA
- Magnesium-enhanced lime FGD installed 1990s, designed for 95% SO_2 removal, 5 modules operate typically with 1 spare
- Typically burns Northern Appalachian High Sulfur (up to 7.5 lb SO_2/mmBtu)

Case Study A History

- Typically see higher than average mercury concentrations at the stack on this unit
- Typically see higher opacity than other similar units due to ESP design and condition
- ORP is tracked but is not typical with respect to mercury capture due to scrubber chemistry providing a reducing environment (producing sulfites)
- Testing program designed to look at PM and mercury removal across FGD under different operating conditions in the FGD and ESP and varying loads

Case Study A

- Testing was conducted in March 2012
- ESP outlet ducts and stack tested simultaneously
  - Method 30B – total & speciated traps
  - Method 5 at ducts, 5B at stack
- Varied unit load (high/full, mid, low)
- FGD operating conditions
  - pH, L/G, varied independently and together
- Raised PM to FGD by “detuning” ESP

Case Study A – PM Results

- Stack emissions rate was generally consistent regardless of PM loading to FGD and unit load
- There were two higher result outliers – one at mid and one at low load – further investigation needed to determine if these are related to FGD operation at the lower loads or if they are anomalies
- Varying FGD conditions had no affect on PM at the stack

	Full Load Normal (lb/mmBtu)	Full Load - ESP Detuned (lb/mmBtu)	Low Load (lb/mmBtu)
FGD Inlet	0.015	0.028	0.013
Stack	0.014	0.008	0.012

Case Study A – Mercury Results

- Much higher elemental mercury at FGD Inlet under ESP detuned condition, but elemental mercury removal?!
- Overall mercury emissions rate was lower during this test than seen normally

		Full Load Normal (lb/TBtu)	Full Load - ESP Detuned (lb/TBtu)	Low Load (lb/TBtu)
FGD Inlet	**Hg0**	0.86	2.14	0.07
	Hg2+	7.19	6.29	8.11
	HgT	8.05	8.36	8.18

Stack	**Hg0**	0.56	0.81	0.09
	Hg2+	0.26	0.35	0.36
	HgT	0.81	1.16	0.45

Unit “B” –Characteristics

- 840 MWg unit
- SCR - three layers of plate type catalyst
- 2 ESPs, <200 SCA
- Jet Bubbling Reactor (JBR) installed 2009, designed for 99.5% SO_2 removal
- Typically burns Northern Appalachian High Sulfur (up to 7.5 lb SO_2/mmBtu)

Case Study B History

- Unit B has very marginal ESPs and prior to installation of FGD operated with a gross load derate due to PM/opacity limits
- Testing program was originally designed to evaluate several things simultaneously
  - Cause of ID fan erosion and determination of optimal operating conditions to avoid it
  - Mercury & PM removal efficiencies across FGD

Case Study B

- Testing was conducted in April 2012
- ESP A & B outlet ducts and stack tested simultaneously
  - Method 30B – total & speciated traps
  - Method 17 at ducts, 5B at stack
- Varied oxidation air rate to JBR
  - Took ORP (Oxidation Reduction Potential) readings during varied oxidation air test runs
  - ORP varied 150-300 mV but readings were inconsistent likely due to problems with the handheld probe

Case Study B – PM Results

- ESP A & B outlet ducts see very different PM loading rates despite similar gas flows
- JBR achieved 80%+ PM removal under all loads/operating conditions tested

	Full Load Average lb/mmBtu	**Mid Load Average lb/mmBtu**	**Low Load Average lb/mmBtu**
ESP A Outlet	0.151	0.061	0.083
ESP B Outlet	0.088	0.02	0.074
Stack	0.0082	0.0049	0.0060

Case Study B – Mercury Results

		Full Load Average lb/TBtu	Mid Load Average lb/TBtu	Low Load Average lb/TBtu
ESP A Outlet	Hg2+	10.74	11.29	12.58
	Hg0	1.03	0.49	0.21
	HgT	11.77	11.78	12.74
ESP B Outlet	Hg2+	14.38	11.86	8.63
	Hg0	0.72	0.4	0.45
	HgT	15.1	12.26	9.08
Stack	Hg2+	0.07	0.07	0.27
	Hg0	1.16	0.45	0.11
	HgT	1.23	0.51	0.38

Case Study B – Mercury Results

		Full Load Average	Mid Load Average	Low Load Average
	Hg2+	99.4%	99.4%	97.5%
	Hg0	-32.6%	-1.1%	66.7%
% Removal	HgT	90.8%	95.8%	96.5%

- Mercury re-emission under full load operation
- Higher % of elemental mercury going into the FGD from ESP A
- Random sampling from other time periods shows even higher amount of elemental mercury being emitted
- Related to the high PM going into the FGD?

Next Steps

- Plan for more testing of mercury at FGD inlet/outlet with ESP detuned
- The next unit to test will be equipped with a JBR and continuous mercury monitoring at FGD inlet/outlet
  - Unit is similar to Unit “B” in coal quality & FGD design
  - Testing was planned for early October but had to be deferred
- Possible re-test on Unit A, which currently has continuous mercury monitoring at FGD inlet and stack
- Plan to monitor ORP during testing

Questions/discussion