Electrostatic Precipitators

"In a Mercury Constrained World"
Outline

- Mercury Rulings – *where we are now*
- Forms of Mercury
- Effect on Electrostatic Precipitators
  - Demolition of existing / build new?
  - Add to existing equipment?
  - Modify existing systems?
Forms of Mercury

- Every coal has all forms
- Some coals have more of one or the other
- Elemental (normally vapor)
  - Can be as high as 80% of the mercury in some coals
  - Sub-bituminous
  - Lignite
- Water soluble (typically Hg$^{+2}$)
  - Bituminous
Mercury Removal Regulations

- Dec. 2000 – EPA deems it necessary and appropriate to regulate coal and oil fired electric utilities
- Jan. 2004 – EPA Proposes two (2) basic approaches
  - MACT
  - CAP and TRADE
  - “Clean Air Interstate Rule” 70% reduction 48 tons per year to 15 tons per year
- May 2005 – EPA Issued final ruling based on various petitions
  - “Regulation of Electric Utility Steam Generating Units was Neither necessary Nor Appropriate”
  - CAMR – Clean Air Mercury Rule
- Feb. 2008 – State of New Jersey vs. EPA
  - US Court of Appeals vacates EPA’s Rule removing power plants from the Clean Air Act list of Sources of Hazardous Air Pollutants
- Jan 2009 – Awaiting Supreme Court response on review of US Court of Appeals decision
Do they effect me?

• Absolutely
• Will the requirements vary for different fuels?
• Many states are considering 90% removal.
  – This is an issue for many people
  – Including those with scrubbers burning eastern coals
Effect on the future of electrostatic precipitators

- Demolition of existing equipment
- Add-ons to existing equipment
- Modifications to existing equipment
Considerations

- Fuel used
- Age and condition of precipitator and unit
- Structural considerations
- Permitting requirements
Demolition / New equipment

- Remove the ESP and build a FF with ACI
  - Capital cost of the fabric filter
  - ACI injection rates of 1 lb/mmracfm
  - Loss of ash sales
  - Temperature controls may be required
Add to Existing

- Fabric Filter after the ESP
- Add ACI or other sorbent to the ESP
  - Injection rates of 8 lb/mm/acfm or higher
  - Temperature control may be required
  - Precipitator may not react well to the increased load
  - Loss of ash sales?
  - 90% reduction?
- Bromine Injection in furnace
  - Still in research

- Granular filter after the ESP
- EPRI Toxecon® or equivalent
  - Retains ash sales
  - Retains the investment in the precipitator
  - Recycles ACI for reinjection
  - Capital cost of the fabric filter remains
  - More complex
Modify Existing

- Rebuild ESP into a fabric filter
  - Reuses many components
  - Loss of ash sales
  - Lower ACI injection rate than ESP
- Build baghouse into later fields of ESP
  - On larger ESP’s this may be an option
  - Tested, but not fully researched
Cost Analysis Basis

- 250 megawatt / 1,000,000 acfm unit
  - 20 years old
  - Good condition
  - PRB coal
  - Meets current permitting requirements
  - Structurally usable
Costs

- New Fabric Filter ~$80+ mil
- Fabric Filter Conversion ~$60mil
- ACI Injection ~$400k /lb/mmacfm
  - For a FF likely to be $600 to $800 k/year
  - For ESP likely to be $3 to $4 mil/year
- Ash Sales ~ $2 mil/year
- Cost of Land filling ash ~ $2 mil/year
The existing ESP is still the best choice for the foreseeable future

- All of the high capital cost options assume no changes in technology. This is required to amortize the capital costs, but is inaccurate.
- Newer sorbents are being investigated that have less impact on ash sales.
- New furnace injection techniques are being developed.
- Many hybrid designs are being tested and proven.
Important differences in dusts

- Resistivity
  - Typical PRB fly ash resistivity = $10^{13}$
  - Typical activated carbon resistivity = $10^5$

- Density
  - Typical fly ash = 120 lb/ft$^3$
  - Typical PAC = 30 lb/ft$^3$

- Particle size
  - Typical fly ash = 15 micron
  - Typical PAC = 20 micron
Dust mixtures can be an issue

- Typical coal fly ash has relatively high resistivity causing high voltages and low currents in the ESP.
- Typical activated carbon is very low resistivity.
- To collect low resistivity dust requires low voltages and very high currents.
- This causes the low resistivity dusts to cascade through the ESP in a catch and release fashion.
- This is especially true if the low resistivity dust is also small and lightweight like activated carbon.
How to handle this mixture

- Very high voltages in the inlet fields
  - This is no different than present operation
  - Enhances charging and collection in early fields

- Very high currents in the outlet fields
  - High currents are required to retain low resistivity dust
  - Only possible once the vast majority of high resistivity dust is removed.

- Sectionalization
  - Favors sectionalization in series rather than across flow
  - Many smaller fields
  - High frequency power supplies in later fields
Reentrainment

- Low velocities
  - Typical utility precipitators operate at higher velocities (4.5 to 6.0 ft/sec)
  - This promotes cascade reentrainment
  - Collection of fine carbon is best below 3 ft/sec

- Ash removal leaks
  - Leakage past the ash valves or rotary valves can carry dust from the outlet field right to the exit
Baffling

- Good anti-sneak baffles. Including the sides of the trailing edge of the outlet field
- Skewed flow near the exit
- Additional baffles between fields
Baffling Issues

- Side baffles must be well positioned and continuous.
- Baffles between fields need to be well above the bottom of the collection field.
Other Issues to Watch
Anti-sway System

• This is a vertical post
• Others work, but tracking distance is important
• Must be cleaned
• Carbon build up causes tracking
• More carbon near the outlet
Hopper Level Probes

- Must be clear of obstructions
- Must be designed for a high carbon environment
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