Worldwide Pollution Control Association

WPCA-

Southern Company

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WPCA

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Key Factors in Activated Carbon Injection

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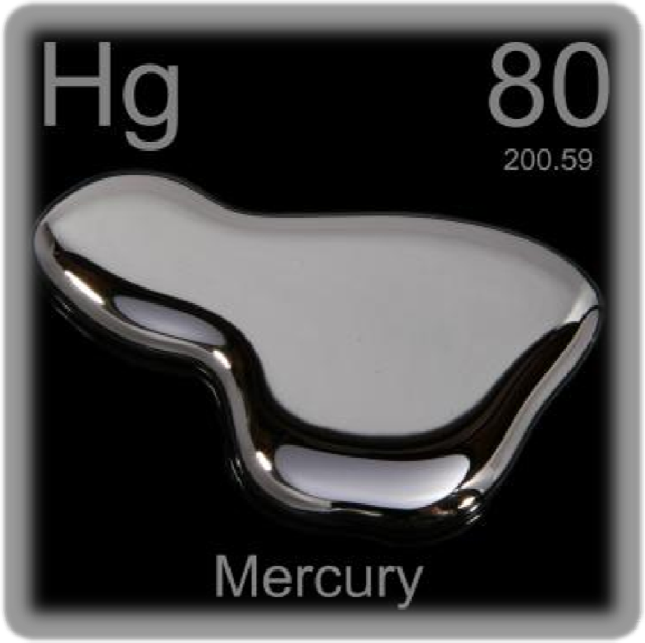
Where are we now…

- Approximately 55-60 units injecting activated carbon for mercury control across the US and Canada.
- Approximately 50 units using $CaBr_2$ injection.
- Mercury and Air Toxics Standard requires compliance in April 2015.
- Activated carbon is the accepted technology for meeting state and MATS mercury emissions limits
- New approaches, new technologies, and better carbons are under development.

Key Factors in Activated Carbon Injection

Two pieces of the puzzle to consider

- Equipment Selection/Design
  - Key lessons learned
  - Key equipment
- Activated Carbon Selection
  - Understanding your unit & mercury
  - Selecting the right carbon



Key Factors in Activated Carbon Selection

First step → define your problem

- Current Hg emission rate
- Required Hg emission rate

Does a solution that fits your unit and fuel choice(s) exist?

Testing is the best method to determine right solution for your unit(s)

Key Factors in Activated Carbon Injection

Factors impacting equipment design and selection

- Design considerations
- Key lessons learned

Powder Activated Carbon is a unique material

- Abrasive
- Does not convey like other “powders”
- Will free flow like liquid when over aerated

Full Scale Testing – Hg

Best method to determine right solution for your unit

- Large focus on testing – now through MATS implementation
- Necessary to achieve the best, lowest cost solution for your units
- Longer term is better – short term/preliminary results can be misleading
- Work with testing company/engineering company to develop test plan – better plan = better results
- Use results to guide equipment design and carbon selection

Equipment Design Considerations

- Start with flue gas flow rate and PAC injection rate
  - Choose realistic injection rate
  - A large difference in design injection rates can negatively impact system design (turndown)
- Silo
  - Sizing: how many days storage/how many units served
  - Density of PAC varies based on raw material – ≈25 -55 pcf
  - Truck/rail unloading system
- Feed train
  - 1 -3 per silo
  - Gravimetric vs volumetric

Equipment Design Considerations

- Control building
  - MCC, building, etc
- Controls Type
  - PLC, DCS, local controls
- Other considerations:
  - Roof slope
  - Dry instrument air (fluidizing air, bin vents)
  - Crane
  - Installation

ACI System Supplier Responsibilities

Design, fabricate, and pre-assemble a fully functional and operating system including:

- Silo system
  - Truck unloading
  - Fluidization system
  - Rotary valve
- Feed Train
  - Feeder type (gravimetric vs. volumetric)
  - Blowers (regenerative vs. PD)
  - Eductors
  - Control Instrumentation
- Injection System
  - Distribution Header
  - Injection Lance

Equipment – Key Lessons

Years of systems experience = several lessons learned:

- Rotary valve wear on gravimetric feeders – isolate rotary valve

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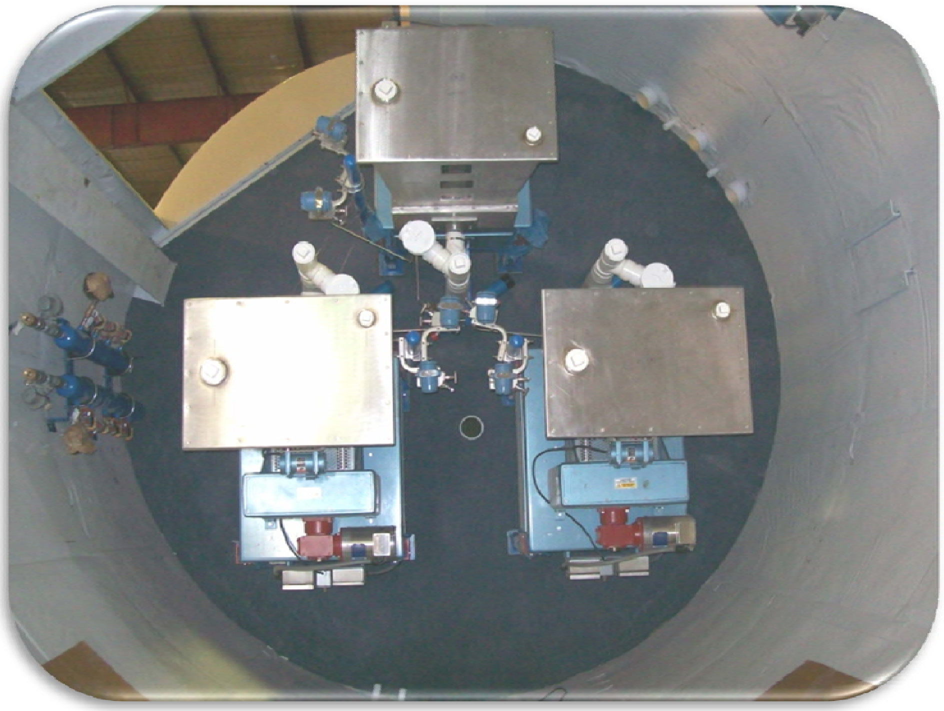
Equipment – Key Lessons

- Pressure variations in gravimetric feeders lead to erratic feeder accuracy
  - Vent to avoid pressure build up



Equipment – Key Lessons

- High Eductor Inlet Vacuum
  - Install check valve to control inlet vacuum
- High wear on eductor discharge piping and elbows with skirted silo
  - Install wear resistant adapter to discharge piping
  - Minimize elbows and bends in transport piping
  - Use ceramic wrapped pipe at elbows and bends

Equipment – Key Lessons

- Diverter Valves
  - Short stagnant line off of the stream feed can plug
  - Mount diverter valves horizontally

Equipment – Key Lessons

- Plugged Lances
  - Lances prone to plugging when there is no air flow through them
  - Diverter valves should be open and blowers running while ACI system is shut down and generating unit is still operating

Key Factors in Activated Carbon Injection

Factors Impacting ACI

- Coal selection
- Air Pollution Control Device Configuration
- High SO3 applications
- Concrete compatibility
- Injection location
- Use of fuel/boiler additives
- Field Service/Optimization

Coal Selection

Coal Selection

- Source
  - Powder River Basin
  - Western Bituminous
  - Eastern Bituminous
  - Lignite
- Key Factors
  - Hg content, %S, ash, and halogen content
- Variability
  - Understanding variance of native mercury content

Air Pollution Control Devices

APC Devices + Coal Selection Impact Injection Rate

- Fabric Filter vs. Cold Side ESP
- SDA vs. WFGD vs. DSI
  - Impact of trona injection
  - Hg re-emission issues
    - Solutions exist – AC or use of an oxidant
  - SDA + FF results
- Impact of SCR
  - Hg Oxidation
  - SO2 to SO3 conversion

ACI with an ESP

Key factors using ACI with an ESP

- Temperature
  - performance declines above 350 F
  - affect moderated with brominated PACs
  - PAC does not work with HS-ESP

- Specific Collection Area (SCA)
  - square ft of plate area per 1000 acfm
  - typical SCA is 300 - 400, range is 100 to 800

ACI with an ESP

- PAC Distribution in the Duct is Critical
  - duct configuration to generate turbulence
  - PAC injection lance design

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ACI with a Fabric Filter

Key factors using ACI with a Fabric Filter

- Temperature Effects
  - performance declines above 350 F
  - moderated with brominated PACs & baghouse design

- Air-To-Cloth Ratio
  - cubic feet of gas flow per square foot of bag surface
  - typical is 8 – 10, newer units may be 6
  - lower number means more contact time with PAC

- Cleaning Cycle Times
  - cycle times adjusted for optimum Hg removal using CEMs

ACI with a Fabric Filter

Key factors using ACI with a Fabric Filter

- PAC Distribution in Duct is Less Critical
  - PAC on the bags simulates a packed bed, better contact
  - PAC injection lance design less important
  - ductwork configuration less important
  - carbon is much more efficient than in ESP units

SO3 Laden Flue Gas

Three cases of SO_3 laden flue gas:

- Native %S content of coal (Eastern Bituminous)
- SO_3 injection for flue gas conditioning
- SO_2 to SO_3 conversion by SCR catalyst

No easy solution

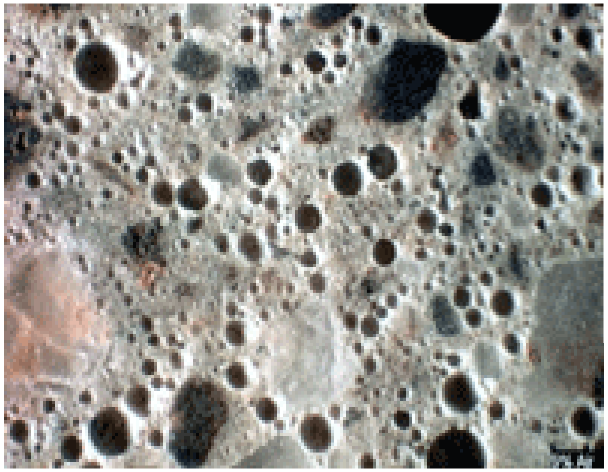
- SO_3 tolerant carbons in development
- DSI for SO_3 control – can have other affects, such as trona interfering with oxidation of the mercury

Concrete Friendly Applications

Activated carbon influences fly ash used in concrete:

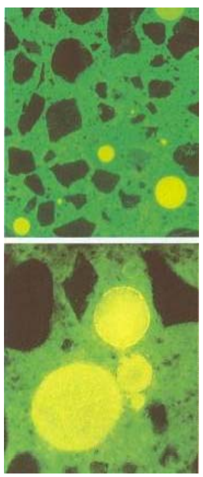
- Adsorption of air entraining agents (AEA)
- Concrete stability issues
- More variability in AEA needed

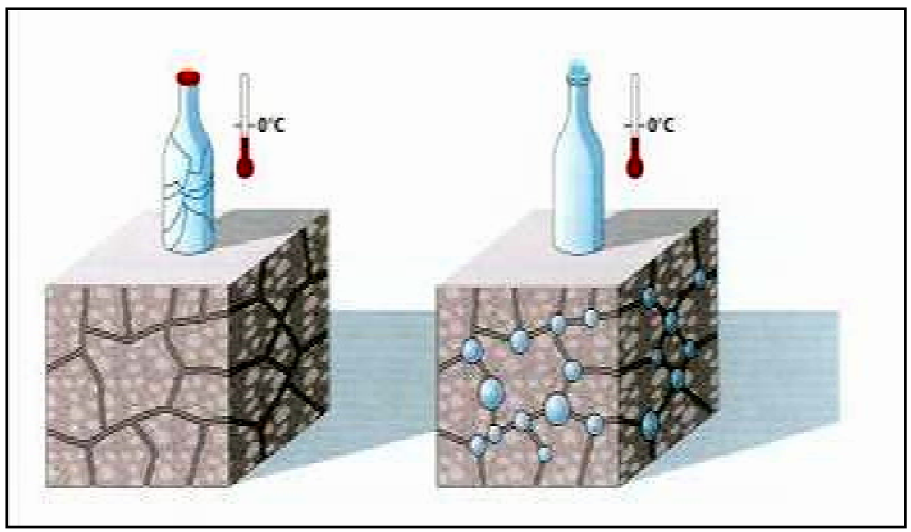
- Fly ash containing AC often not acceptable for concrete
  - LOI
  - Relative Foam Index too high
  - Color



Concrete Friendly Applications

- Relative Foam Index (RFI) used as reference measurement
- RFI is the amount of AEA required for a stable foam in concrete mixture
- Lower RFI the better – less AEA required, assume ≤6 for concrete compatible





Injection Location

Residence Time and Mixing are Key!

- Pre-APH injection
  - Mixing in air heater
  - Longer residence time

- Post-APH injection
  - Goal is long residence time
  - Mixing will not be as good, so may need to compensate with more injection lances
  - Proper lance design
  - CFD modeling is a good option to ensure proper mixing

Boiler Additives

Boiler additives, such as CaBr2, increase oxidation of elemental mercury.

- Low cost solution may be a combination of CaBr2 addition and standard activated carbon.
- Must be aware of possible BOP effects such as corrosion

Field Service/Optimization

Optimization is an ongoing process:

- Utilize your activated carbon supplier to optimize your injection rate
- Upgrade/change carbons as better products come to market
- Focus on low cost solution/lowest total cost of ownership

Key Factor in Activated Carbon Injection

Removing mercury from flue gas is a complex problem

Over come this challenge by:

- Full scale testing – longer term is better
- Select and install a robust system
- Select the right activated carbon for your unit
  - Understand factors impacting selection
  - Optimize carbon usage

No doubts. Norit. Just proof.

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