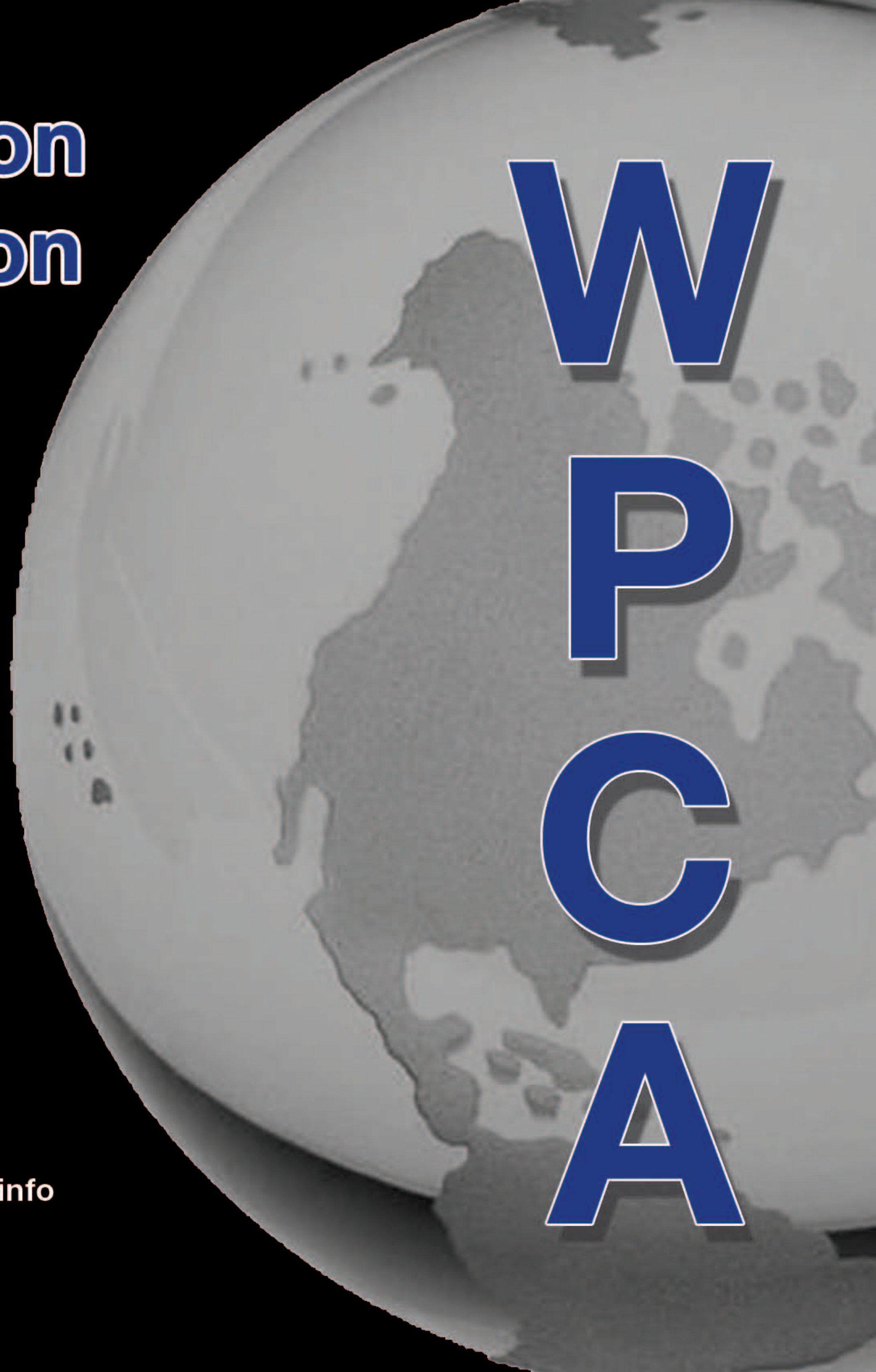
Worldwide Pollution Control Association

Ameren Seminar

August 19–20, 2008

Effingham, IL



WPCA

Vist our website at www.wpca.info

Implications of SOx, NOx, and Hg on SCR and ESP Performance

2008 WPCA – Ameren ESP and SCR Seminar

Alan Ferguson

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Agenda

- 1st topic SCR Description
- 2nd topic Issues with SCR
- 3rd topic Effect of SCR on Plant Systems
- 4th topic Effect of SCR on Pollution Control Equipment
- 5th topic Future Performance Requirements

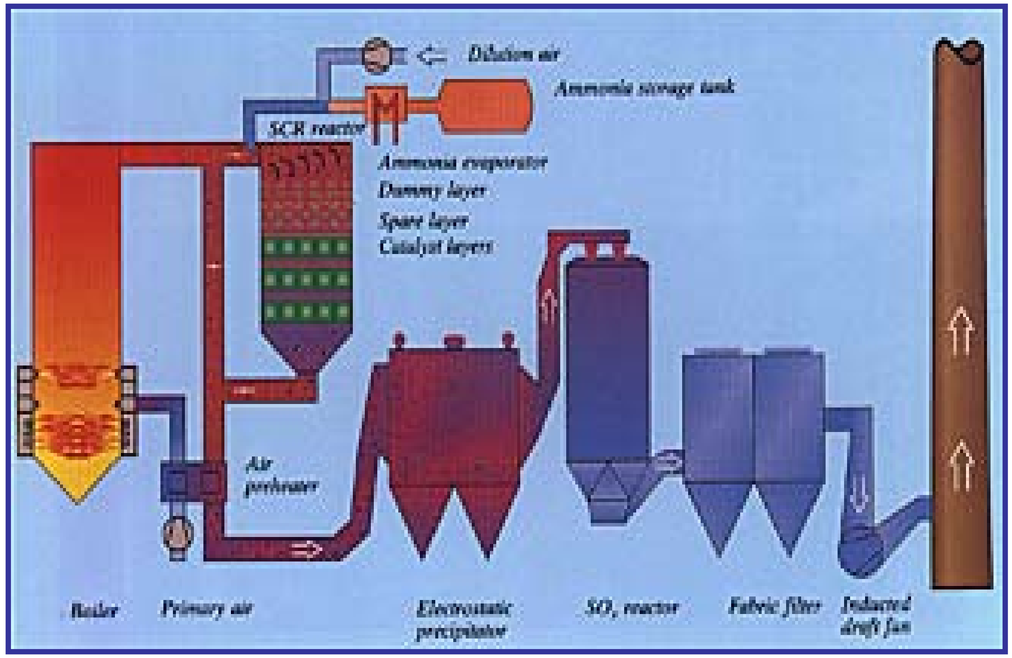
LOW NOx CHOICES

- Firing System Tuning and/or Basic Modifications
- Fuel Switching
- Firing System/Boiler Modification - Possibly Including SOFA Systems, Pulverizer, Pressure Parts, Control System Modifications and/or Neural Networks
- FGR
- SCR (or SNCR) Addition
- Combination of Any of the Above

SCR Configuration

High-Dust SCR

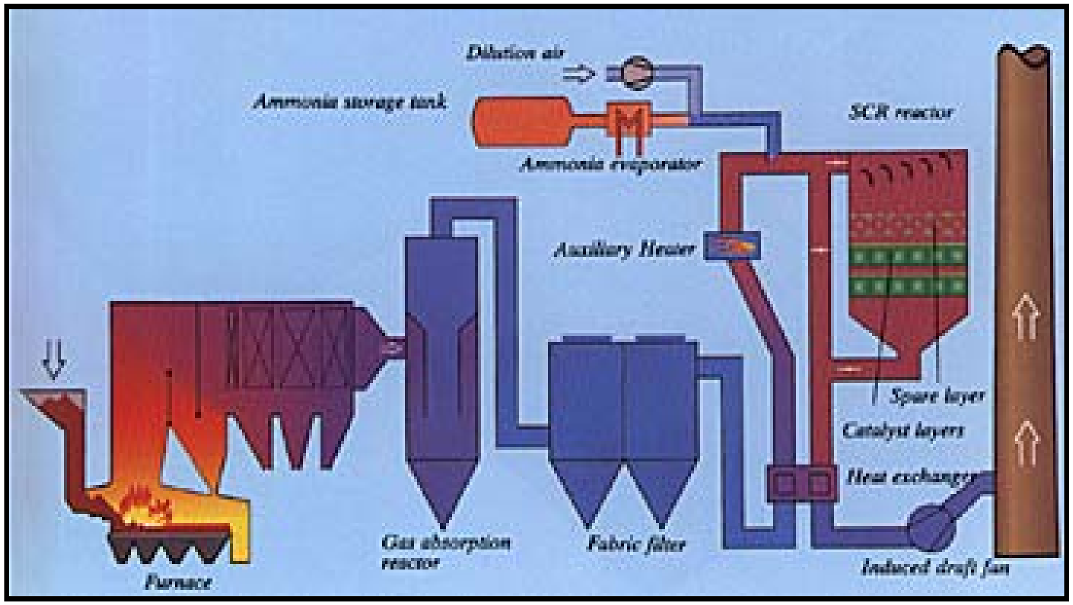
- Reactor Upstream of APH
- Full Dust Load from Boiler Passes through the SCR Reactor
- Larger Catalyst Channels (Pitch) Required to Prevent Plugging
- Shorter Catalyst Life
- Cost Effective Solution



TYPES OF SCR

Tail End System:

- Very Low Dust Load in the Reactor
- Long Catalyst Life
- Heat Exchanger/ Supplemental Heater Required after ESP or FF to Increase Temperature to About 575°F
- Much Smaller Catalyst Channels (Pitch) Increase Packing Density



NOx Reduction

- Low NOx Burners
  - LOI
- SNCR
  - Ammonia Slip
- SCR
  - Ammonia Slip
  - SO_2 / SO_3 Oxidation
  - Mercury Oxidation

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General

- Three Sources of Ammonia can be used
  - Anhydrous
  - Aqueous
  - Urea
- Local Rules, Permit Issue
- An Analysis of Risks and Consequences for each Plant

Large Particle Ash (LPA)

- "Popcorn" from Combustion
- Slag from Boiler Tubes
- Agglomerated Ash Particles
- Over 2 to 3 mm
- Plug Air Heaters
- Plug Screens Over Catalyst or Catalyst
- Poor NOx Performance, Erosion from High Velocity

SO_2 Oxidation

- Catalyst Oxidizes SO_2 to SO_3
- Similar to Catalytic Converter on Cars
- The formulation affects oxidation
- Low Oxidation Rates Achievable at Higher Catalyst Cost

Bisulfate Formation

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$$NH_{3(g)} + SO_{3(g)} + H_2O_{(g)} \longrightarrow NH_4HSO_{4(l)}$$

Causes:

1. High concentrations of SO_3 and unreacted ammonia in the flue gas
2. Low operating flue gas temperature

Countermeasures:

1. Design for low ammonia slip
2. Design catalyst for low SO_2 to SO_3 oxidation rate
3. Install economizer bypass system
4. Install ABS Tolerant air heater baskets
5. Reversible with high operating temperature

Control Issues

- Unreliable NOx analyzers
- Time delay of samples
- Overfeed of ammonia during step changes to process (loss of pulverizer)
- Underfeed during ramp up
- Sample / Hold during monitor calibration
- Ammonia slip monitors

Seasonal Operation

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- Isolate Catalyst from Gas Path at end of Ozone season
- Purge Flue Gas from SCR reactor
- Use Sonic Horns or Soot blowers to clear ash deposits
- Maintain Catalyst above dew point during storage
- Near Zero aging when stored properly
- Damper Seal Air Pressurization of Reactor

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SO_2

- SO_2 does not hinder reduction
- SO_2 oxidizes to SO_3
- SO_3 combines to form Ammonium Bisulfate (ABS)
- SO_3 can condition ash for ESP
- ABS fouls Air Heater and possibly ESP or FF

Air Preheater

- Catch place for ammonium bisulfate
- Temperature just right for ABS
- Basket Design

Fans and Duct

- Fans designed for system loss
- Ammonium bisulfate if temperature is right
- Duct designed for even distribution and no ash piles

Ammonia

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- Needed for the NOx reduction
- Combines with SO_3 forming ABS
- Can have its own emission limit
- Removed in WFGD
- Conditions ash for ESP
- Can be plant safety issue

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Particulate

- High Dust SCR can handle
- Requires cleaning system for catalyst
- Can be conditioned by SO_3 / Ammonia
- Collection in ESP or FF

ESP / Fabric Filter

- Collects fly ash
- SCR impact low
- Ammonia / Ammonium bisulfate / carbon

Ammonia Impact

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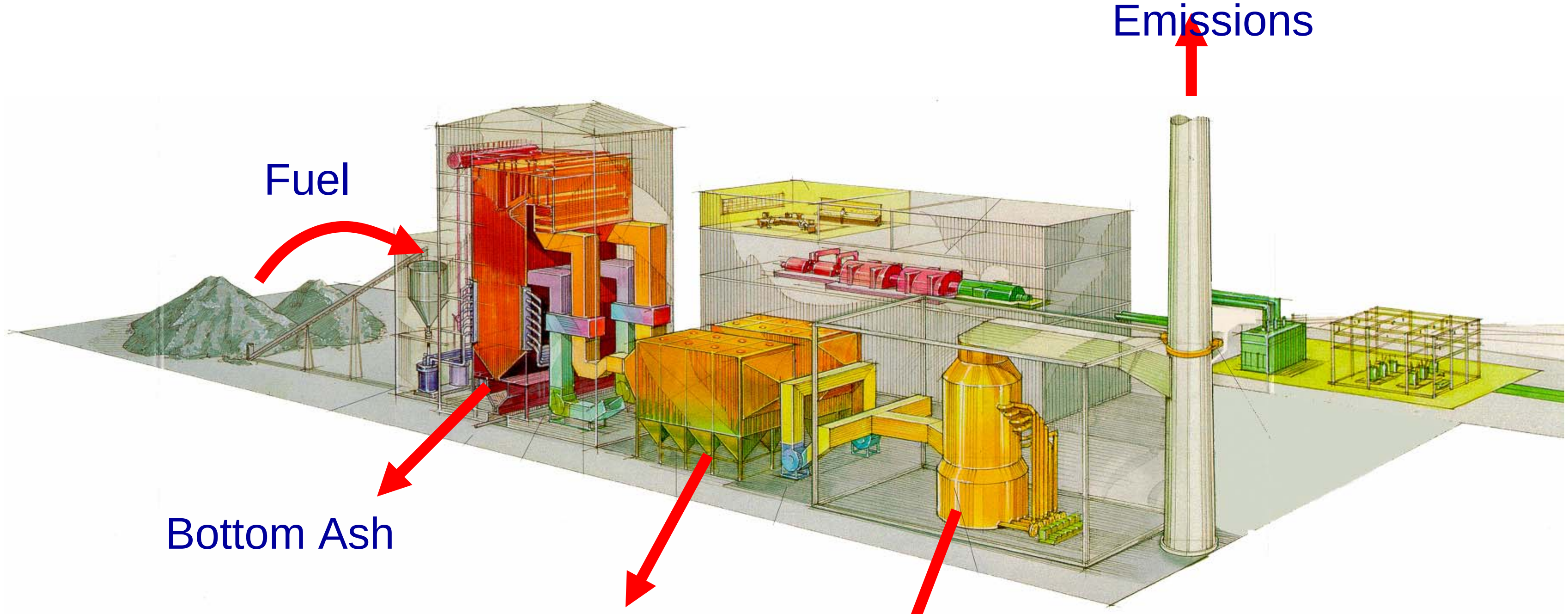
- Ammonia from the SCR will end up in/on and will affect
  - APH surfaces
  - Fly Ash
  - ESP Collector Plates
  - Filter Bags
  - FGD Waste Water
  - FGD Gypsum
  - FGD Oxidation

Ammonia Levels in Fly Ash after SCR plants

- Plant measurements reported levels of ~ 100 ppm NH_3 in fly ash at NH_3 gaseous slip levels of ~ 5 ppm
- High slip
  - Poor Measurements
  - Poor Distribution
  - Variable NOx Distribution
  - Catalyst Deactivation

Mercury Control

The Fate of Trace Elements

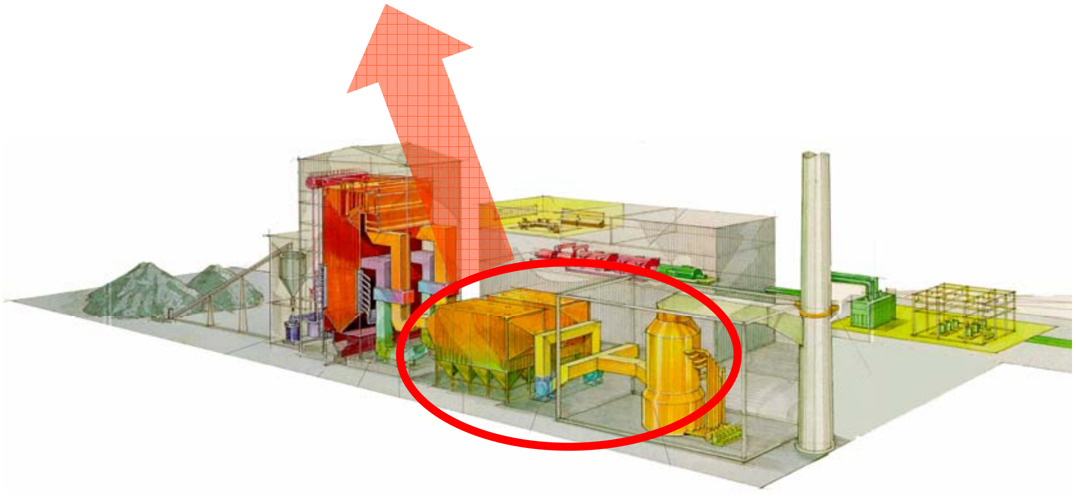


Coal	Gas
	Hg°
Hg	Part Hg
	$HgCl_2$

Mercury Control

Conventional Technologies

- SCR oxidation promotes collection by downstream equipment
- Particulate collectors
  - Capture by ESPs ranges from 5-50%
  - FFs capable of up to 50-90% capture
  - Sorbent injection can increase capture to 90+%
- DFGD/FF capture ranges from 50-95+% capture
- WFGD effective in collection of oxidized Hg
- Conventional APC equipment offers Hg capture ranging 10-90+%
  - Highly dependent on speciation
  - Costs well known



Mercury Control

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Developing Technologies

- Sorbent injection
  - Lower cost sorbents
  - Higher capacity sorbents
- Post-combustion oxidation
  - Convert elemental to oxidized Hg
  - Developing technologies based on oxidizing agents, catalytic/electro-catalytic conversion
- Emerging and experimental technologies hold promise of high capture rates (>90%)
  - Performance/reliability risk
  - Cost risk
  - Timing of mandated reductions

Mercury

- Elemental Hg is oxidized in SCR
- Easier to collect in downstream equipment
- Carbon injection for collection
- Carbon affects ash sales
- Carbon affects ESP collection

- Wet scrubber
  - May not be good for SO_3
- Dry Scrubber
  - Better for SO_3
- Will collect ammonia
- Ammonia products in FGD byproduct

SO_3/Visible Emissions

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- Increasing concern
  - SCR impact
  - Fuel switching
  - Alternative fuels
  - $PM_{2.5}$ standards
  - Regional haze
- Wet ESPs are available and effective, but costly
- Alternatives?
  - Gas-to-gas reheat
  - Condensing heat exchanger
  - Sorbent injection
  - Dry FGD

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CO_2 Capture Systems

- Need clean gas stream
- SO_2, SO_3, NO_2 are “poisons” for amines
- Particulate will foul liquid streams
- Mercury unknown but probably not good

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