Availability of Mercury Control Technology

Pennsylvania Mercury Rule Workgroup Meeting

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David Foerter

Institute of Clean Air Companies, Inc.

www.icac.com

1730 M St., NW, Suite 206

Washington, D.C. 20036

202-457-0911/dfoerter@icac.com

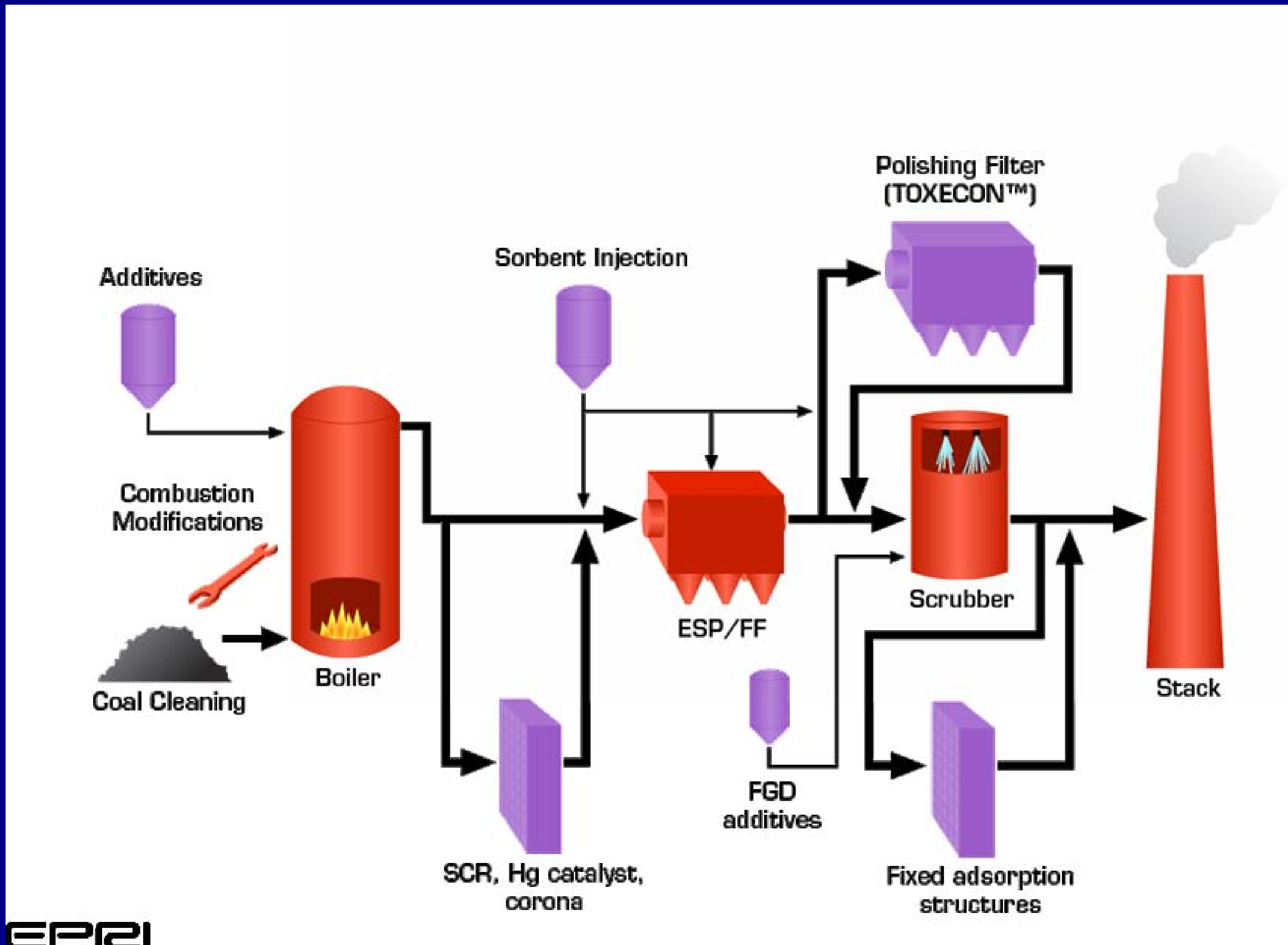
What do we know about controlling mercury?

- Solutions come in different shapes and sizes
- Already tremendous progress and investments
- Regulations create market certainty … driving R&D and commercial competition for lower cost solutions
- Most mercury control is about finding new and improved uses for existing technologies …. and then some.

Wide Range of Control Options

- Co-benefits
  - SCR, FGD, ESP, FF, etc.
- Enhanced co-benefits
  - Chemical oxidants
  - Adding additional catalyst layers or new oxidizing catalyst
  - Non-carbon based sorbents
  - Chemically-Enhanced sorbents
  - High energy excitation
- Combustion modifications
  - In boiler modifications to oxidize mercury and increase amount of carbon (i.e. research and demos at Lehigh University and GE Energy)
  - State-of-the-Science Ultra-Super Critical Boilers with advanced APC
- Precombustion
  - K-fuel : cost in scrubbing coal; can be combined with other controls
  - Gasification: up front equipment cost to convert from solid to gaseous fuel; requires pollutant disposal
- Sorbents (ACI/PAC)

Power Plant Mercury Control Options



Some Bituminous Coal Control Strategies

Bituminous coals typically have moderate-high Cl/Br content and higher sulfur levels:

"the right stuff" for mercury and SO_2 control

Configuration

No FGD: ACI/PAC, and add fabric filter option if:

- desire higher mercury removal efficiency, and/or
- ash sale

Dry FGD: ACI/PAC (*may already have fabric filter*)

Wet FGD: improve and control mercury oxidation

Co-Benefits/Multipollutant Approach – timing and labor

- Wet FGD:
  - 19 to 30 months to construct (avg. in mid-20's); 180 man-years
  - Components: grinding mill, slurry prep., reactor vessel, dewatering and gypsum stacking
- SCR:
  - 13 to 24 months to construct (avg. in low 20's); 170 man-years
  - Components: structural steel, NH_3 injection grid, catalyst reactor bed, catalyst, by-pass duct (?)

* Need for early planning decisions

Recent Wet FGD Co-Benefit … Plus

Mount Storm Site Test (WV)

- Eastern Bituminous Coal
  - medium sulfur (1.82%)
  - 4,000 tons/day
- 1662 MW (3 units combined)
- Air Pollution Controls
  - SCR – 2 layers
  - ESP
  - wet FGD – forced oxidation limestone

Results of Co-Benefit … Plus

70% mercury removal with only wet FGD

- some mercury re-emission at outlet

80% mercury removal with wet FGD plus additive (w/o SCR)

- additive stopped mercury re-emission
- SO_2 removal by wet FGD system not impacted by additive technology

90% plus mercury removal with wet FGD & SCR

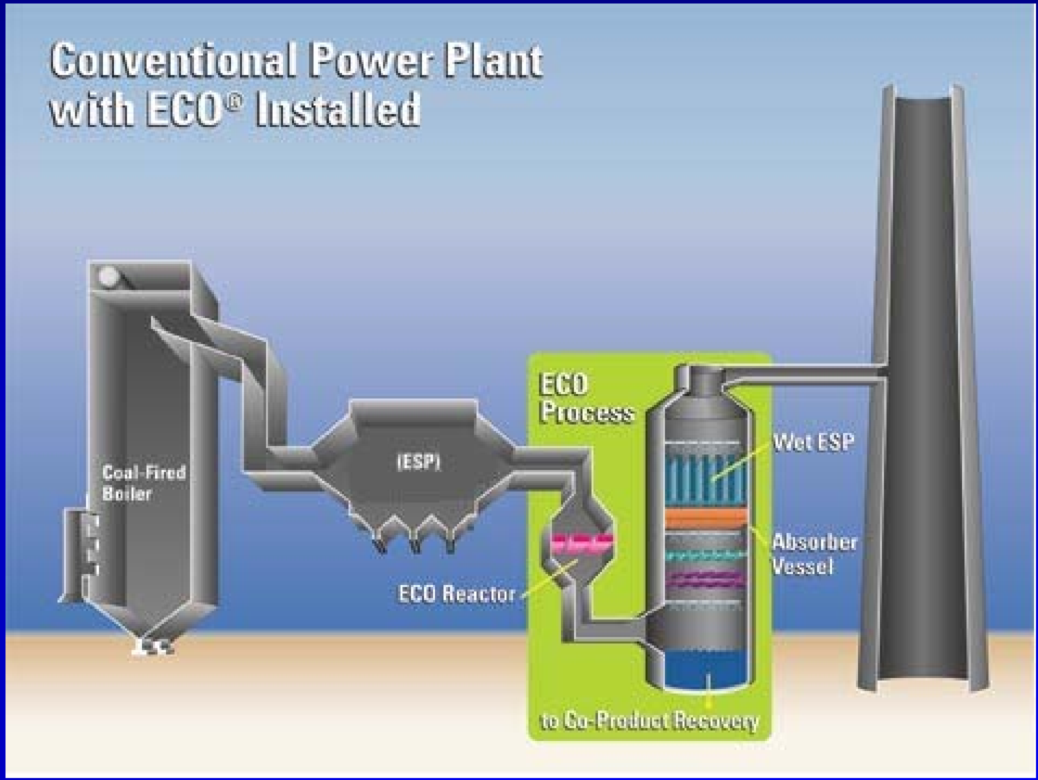
- > 95% of mercury in oxidized state after SCR
- similar results with/without FGD additive (no mercury re-emission to control)

- Demonstrated improvements using wet FGD additive process (B&W patented sodium hydrosulfide)
  - Improved removal of mercury w/o SCR in-service
  - Cost-effective incremental mercury removal (w/o activated carbon injection)

Additional Multipollutant Control Options

Powerspan ECO Process

- Integrated Control Approach
- High Energy Corona



- First Energy Pilot Plant
  - Burger Plant - 50 MW size
  - 98% SO_2
  - 90% NO_x
  - 80-90% Hg
  - 95% $PM_{2.5}$
- Commercial Application
  - FirstEnergy 215 MW Bay Shore Plant – Unit 4
  - Operational 1st Quarter 2006
  - Costs $100 million
  - Creates Saleable Fertilizer Byproduct

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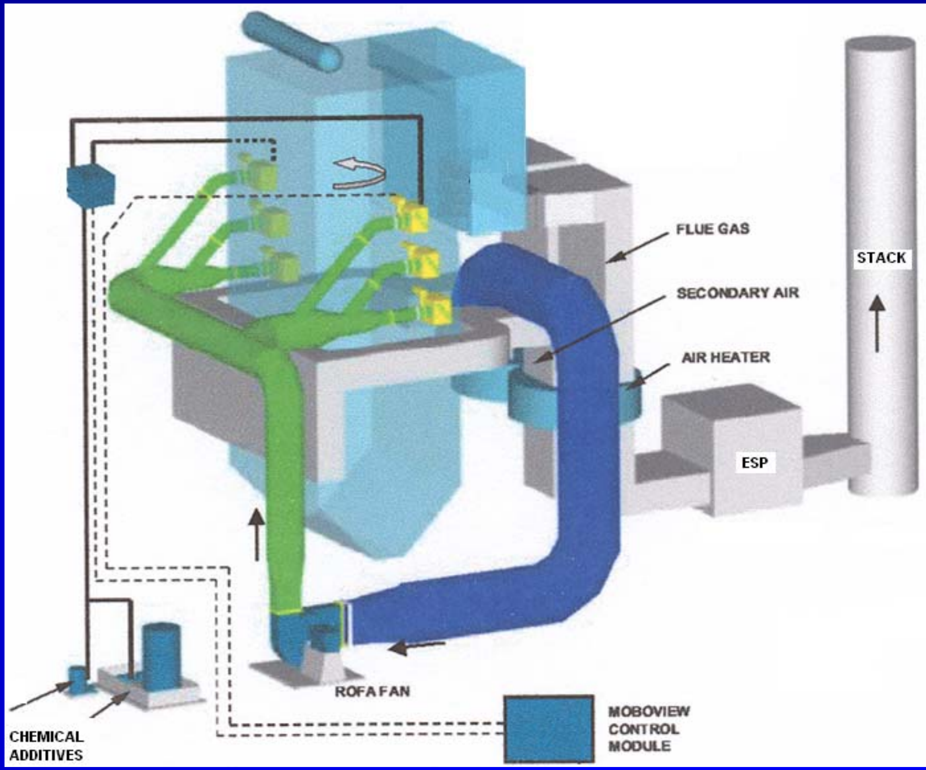
Additional Multipollutant Control Options (cont.)

Mobotec Rofa & Rotamix Technologies

- MINPlus - Sorbent Injection in Boiler
- Scrubber After Boiler



- Performance
  - 60 % NO_x
  - 65 % SO_2
  - Up to 90 % Hg
- Commercial Application
  - Minnesota Power
    - Taconite Harbor Energy Center
  - Startup 2006-2008 timeframe
  - $60 million (includes NO_x control for Laskin Unit too)

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Precombustion Control Option

KFx K-Fuel Process

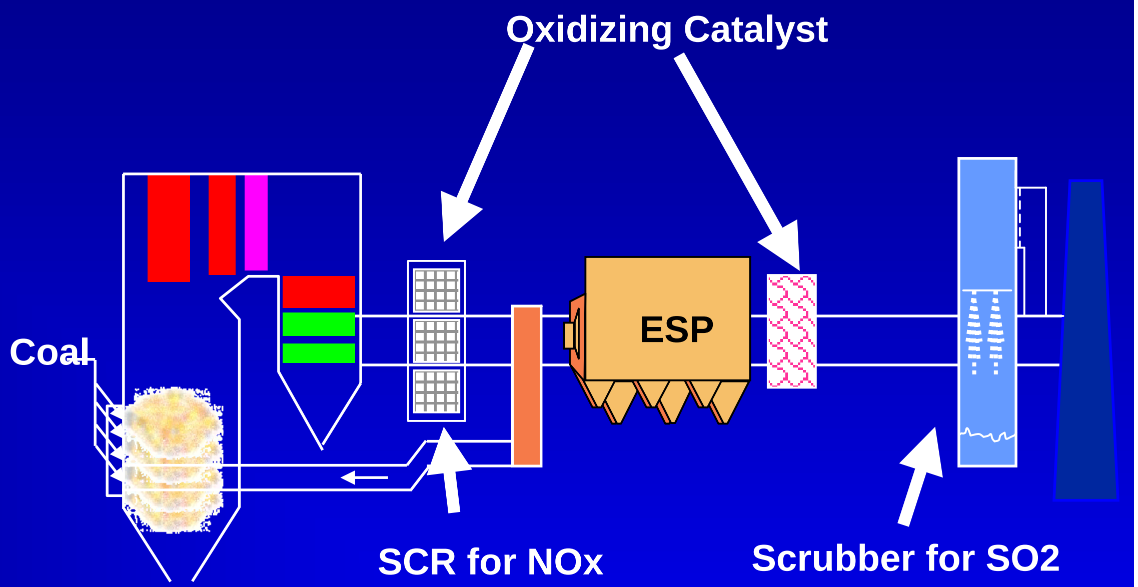
- Coal Cleaning
- High Temp. and Pressure
- Western Low Btu Coals

- Benefits
  - Increases BTU by 30-40%
  - Removes Pollutants
    - 70% Hg
    - 30 % SO_2 and NO_x
    - Potential Tax Incentives
- Production Facilities
  - Gillette, WY – 750,000 tpy (2005)
  - Buckskin Mine, WY – 4 MMtpy (2008)
  - Coal Creek Mine, WY – 8 MMtpy (2008)
  - Supply Approximately 3000 MW of Coal-Fired Plant Capacity

Postcombustion Control Option - Catalytic Oxidation

Catalytic Oxidation

- Converts Hg^0 to Hg^{2+}
- Hg^{2+} Water Soluble



- Configurations
  - Catalyst in SCR
  - Catalyst before Scrubber
  - Multiple Vendors & Configurations
- Application & Performance
  - Oxidized Mercury (Hg^{2+}) Captured in Scrubber
  - Applied to Coals w/ High Elemental Mercury (Hg^0)
  - 5 to 50 % Additional Capture Hg

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General Improvements for Mercury Control

- Techniques to enhance and control mercury oxidation
- Techniques to minimize re-emission
- Potential impacts on by-products
- Less capital intensive techniques
- Cost of mercury removal is coming down

Continuous Emissions Monitoring

- Continuous Hg measurements are being made today
  - At least 6 suppliers of instruments
  - Current instruments are highly accurate* but high-maintenance
  - Technology rapidly advancing toward increased reliability and less frequent maintenance so it could be operated by plant personnel
- Compliance and/or real-time control information

** CEMS that have passed RATA are at least as accurate as the reference method*

Summary of Other State Rules and Programs

Connecticut

- 2003 state legislation
- 2 facilities affected
- 0.6 lb/TBtu or 90% by July 2008; 2012 review of all sources
- "soft landing flexibility" – if done properly and can't meet limit, consider for alternate limit
- CEMS if available

New Jersey

- 2004 rule adoption of broad industry mercury control (7 bit. coal-fired, iron & steel, MSW & med. Incinerators)
- By 12/15 2007 achieve 90% or rate of 3.0 mg/MW-hr on annual rolling avg. weighted by MW output
- Flexibility: if enforceable multi-pollutant agreement, then 12/15 2012; potential plant averaging
- Quarterly stack testing; CEMS if federal performance specification and technology available

Summary of Other State Rules and Programs (cont.)

Massachusetts

- 2004 adoption of final caps (multi-pollutant)
- 4 facilities affected; bituminous
- 2 Phase Program
  - Phase 1: By 2006-2008 achieve 85% or 0.0075 lb/net GW-hr of electricity generated (annual rolling avg.)
  - Phase II: By 10/1 2012 achieve 95% or 0.0025 lb/net GW-hr
- Flexibility: early reductions, off-site reductions, plant averaging
- CEMS by 2008

Wisconsin

- 2004 regulation requires adoption of federal rule
- 4 utilities with 42 units (>25 MW) affected; bituminous/subbituminous
- 2 Phases: 45% reduction by 2010; 75% by 2015
- 80% by 2018 (to encourage additional progress)
- New & modified units capped at 10 lb/yr
- Flexibility: variance requests based on costs or technology availability; early reduction banking starting 10/1 2004; remain at Hg baseline if opt for 2 of 4 pollutant reduction requirements

Other States: legislation, consideration

Delaware

Indiana

Michigan

Montana

Illinois

New Hampshire

Minnesota

North Carolina

Iowa (permit)

STAPPA/ALAPCO Model Rule

- Released Nov 14, 2005
- Flexibilities:
  - Annual rolling averages
  - Averaging/bubble emissions across facility
  - Two phases
  - 2nd Phase option is multipollutant commitment
  - Promotes facilities continued power generation
  - Slower than MACT; much further & faster than CAMR
  - Coal neutral

Keys to Cost-Effective Multi-Pollutant Controls: APC Industry Perspective

- Clear timetable and requirements to control all pollutants
  - Multi-pollutant control approach, if aggressive, could simultaneously address mercury, $PM_{2.5}$, regional haze, ozone transport, and 8-hour ozone standard, thus lowering the evaluated cost for each regulatory program
  - Allows development of integrated compliance plans utilizing existing equipment
  - Clarity, enforcement, & flexibility for well-defined unusual site-specific conditions
- Performance-based Rules
  - Maximize incentives for innovation and competition
  - Life is too unpredictable -- e.g., fuel costs, technology innovation -- for government to pick technology winners and losers

For More:

- Go to www.icac.com
- Call us at 202/457-0911
- Email: dfoerter@icac.com or cwhiteman@icac.com