NOx and Multi-Pollutant Compliance Strategies in Light of Regulatory and Market Uncertainties

NETL

2003 Conference on Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) for NOx Control

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Energy and Environmental Strategies

Overview

- Environmental regulations are clear-cut!!!
- Control technologies always work!!!
- Electric generation market is stable and unchallenging!!!

…what is it you're having difficulty with…?

Overview

- **Just heard EPA regulatory summary**

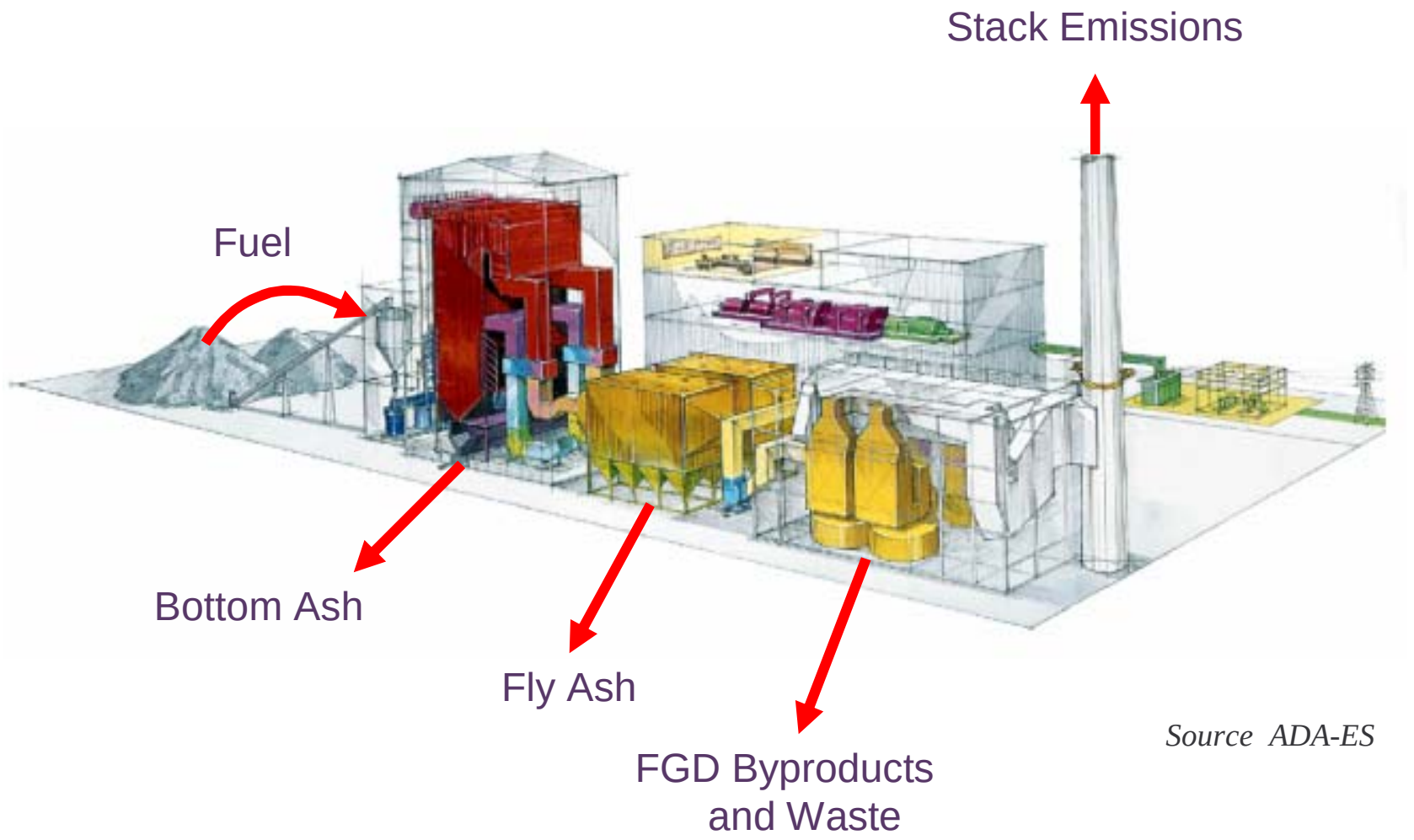
- ***Address/raise questions pertinent to strategic technology discussion and decisions***
- ***No attempt to take the "thunder" out of the many capable presentations you will hear over the next days***
- ***Brief example***

- **Two days of technology "download" from varied experts**

Summary

- **Technology choices challenging in light of…**
  - **Regulatory landscape**
  - **Deregulation**
  - **Aging plants**
  - **“Inter-technology” impacts**
  - **Plant economic performance/life**
  - **“commercial” vs. new technology risk**
  - **New technology “paradigm shift”**
- **Compliance options go beyond control technologies…**
  - **Combined single–pollutant control technologies (e.g. SCR, FGD, ESP, ACI)**
  - **Multi-pollutant control technologies (e.g. Powerspan, etc.)**
  - **Operational curtailments**
  - **Generation technologies /fuels (e.g. IGCC, GTCC, etc.)**

Power Plant Emissions



Source ADA-ES

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Technology challenges…

…some examples

Impact of SCR on Hg Removal

- Bituminous coals:
  - Significant oxidation for high Cl coals;
  - Oxidation decreases over time;
  - Oxidation reduced by presence of NH_3
- PRB coals:
  - Minimal oxidation
- Current R&D to provide further knowledge
- Bottom Line
  - No longer just “delta NOx”
  - Does it help or hurt?
  - How much? Can it become part of my strategy?
  - Can I get/provide “guarantees”?

Impact of SCR and ACI on flyash

- Ash contamination by
  - NH3
  - AC
  - Hg

…can render it unacceptable for recycling

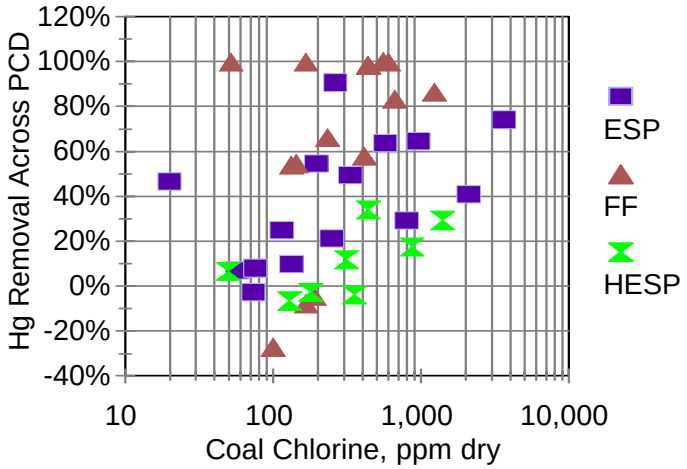
- Can I/how do I treat for NH3 and/or AC contamination?
- Will these issues/costs make me look for other approaches?

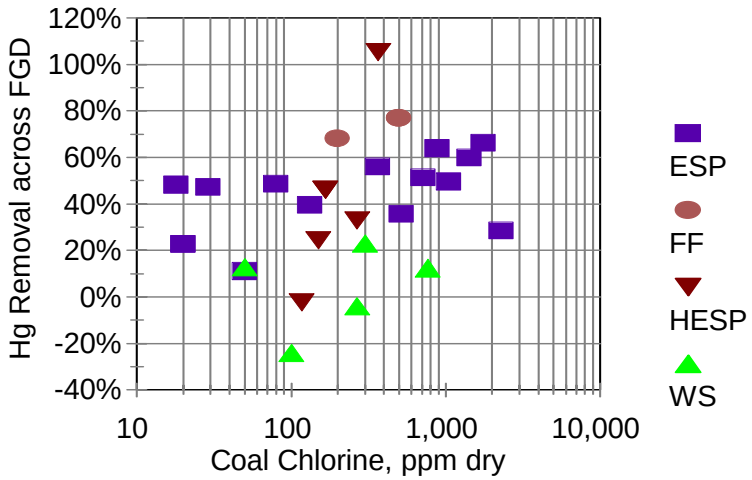
Impact of Dry FGD on Hg Removal

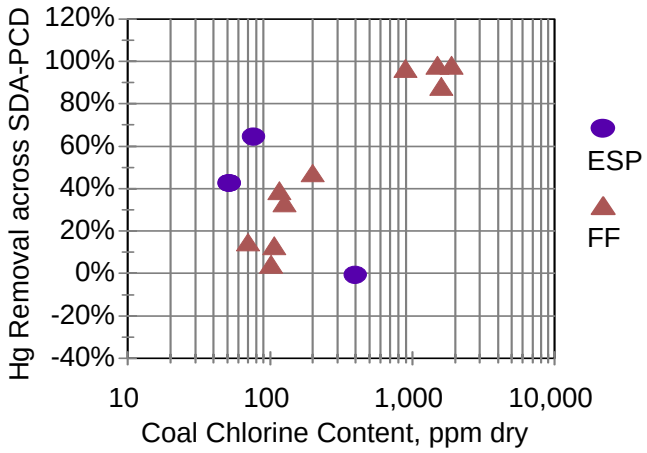
- Test results show poor Hg removal when AC is added in or downstream of SDA:
  - Removal of SO_3 and HCL limit uptake on carbon particles.
  - Ongoing R&D/testing

- Does this favor WFGD?
  - If so, will SCR further enhance Hg removal?

Mercury Removal across APCDs







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Conventional Control Technologies

NOx Control Technologies

- Combustion modifications
  - LNBs, OFA, FGR, Reburn
    - >250GW
    - 20% - 70%
- Post-combustion
  - SNCR
    - 10-12GW
    - 20% - 50%
  - SCR
    - ~110GW
    - 80% - 95%

SO2 Technologies

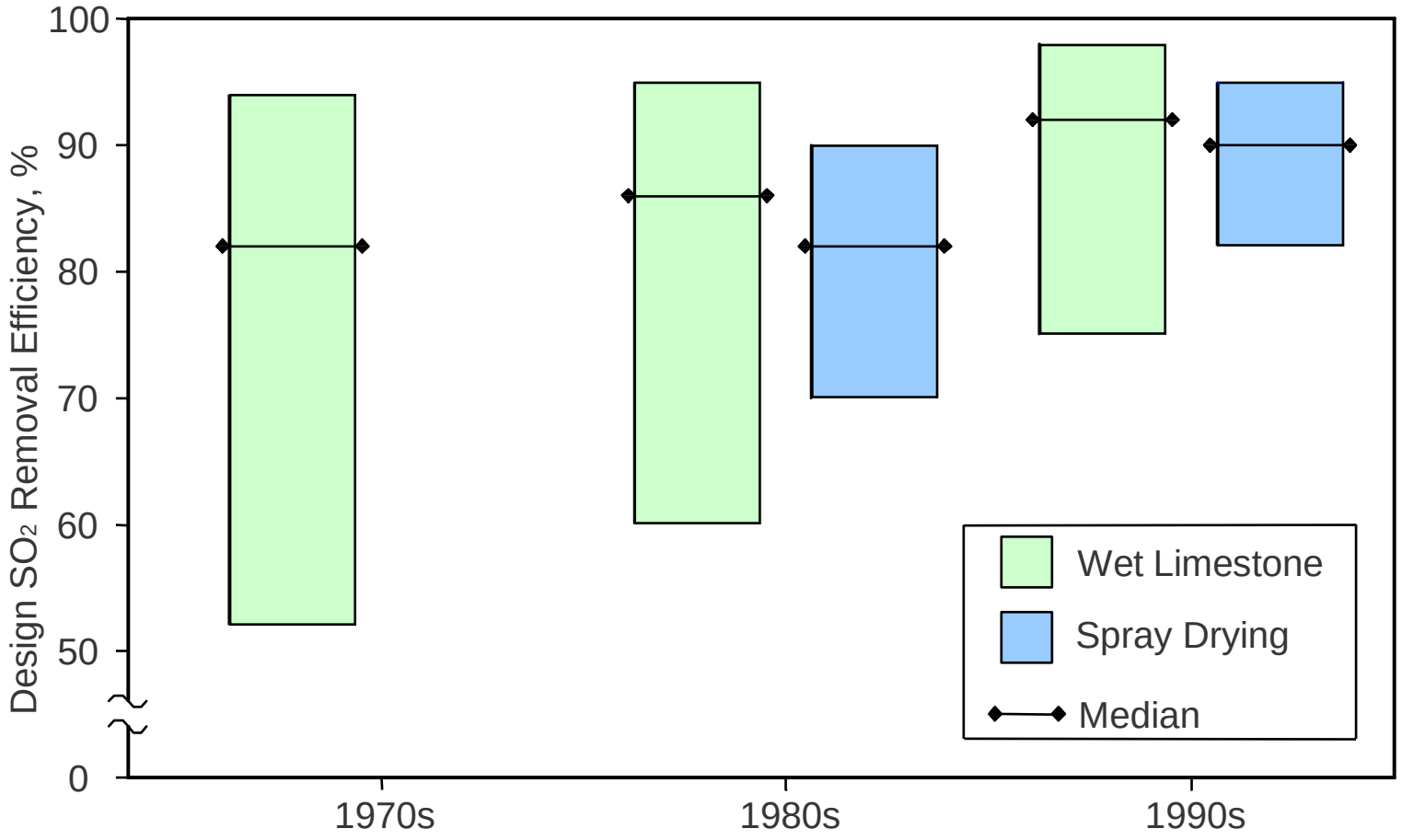
Capacity (MWe) Equipped with FGD

source - EPA

Technology	United States	Abroad	World
Wet	82,092	114,800	196,892
Dry	14,081	10,654	24,735
Regenerable	2,798	2,394	5,192
Total FGD	**98,971**	**127,848**	**226,819**

FGD Performance

source - EPA



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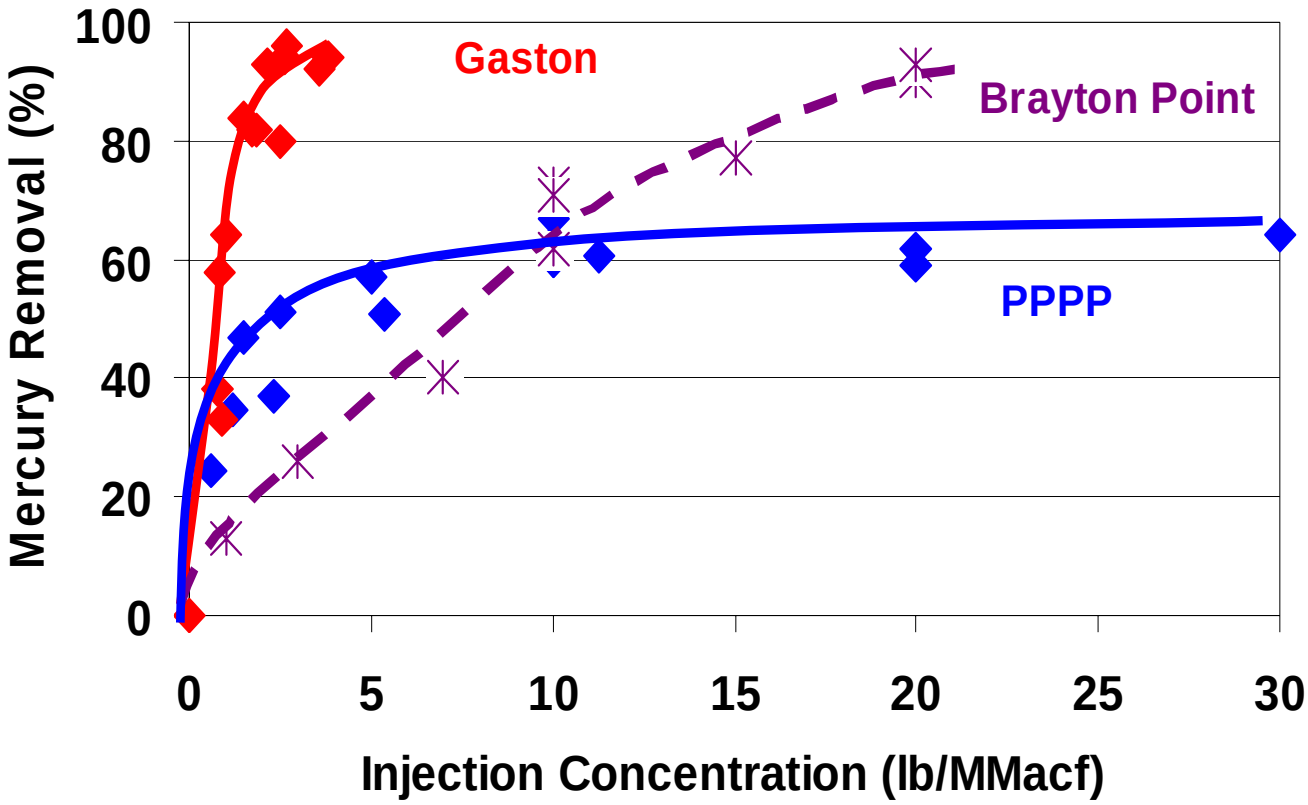
PM Control Technologies for Power Plants

- Electrostatic precipitators (ESPs)
  - 72% of U.S. coal-fired boilers, total PM up to 99.9%, fine PM 80-95%
- Baghouses
  - 14% of U.S. coal-fired boilers, total PM up to 99.9%, fine PM 99-99.8%
- PM scrubbers
  - 2% of U.S. coal-fired boilers, total PM 95-99%, fine PM 30-85%
- Cyclones

Mercury Removal Trends with ACI



Source: ADA Environmental Solutions (2003)

Emerging Technologies

- Reduce costs
- Increase performance
- Increase flexibility

Selected Advanced/Emerging Technologies

WGI-EPRI – AQIV 2003

Technology	Process Description	Commercial status	Controlled pollutants	Removal efficiency	Published costs
ECO	Elecro-Catalytic	Pilot and demonstration	NOx	55-80	
Powespan	Oxidation followed	tests completed	SO2	45	$150-200/kw
	by scrubber and	50MW unit under	Hg	>80	
	wet ESP	construction	metals	>90	
LoTOx	Ozone injection for	Completed 25MW	NOx	90-95	NA
BOC Gases	NO and Hg oxidation	demo - NOx only	Hg	90+	
	and removal by				
	wet scrubber				
Pahlman Process	Dry injection of	Pilot work ongoing	NOx	95+	$150/kw
Enviroscrub	Pahlmalite sorbent	NOx-SO2 demonstrated	SO2	99	
		separately			
AIRborne	Dry sodium injection	CCPI project - 525 MW	NOx	40	
B&W	or wet sodium	start-up 2007	SO2	85-95	
AIRborne Technologies	scrubbing with multiple		HCl	90	$170/kw
	options for fertlizer		metals	NA	
	products				
K-fuel	High energy fuel from	Testy burns completed	NOx	33	
KFx	low quality coal feed	of K-fuel in WY	SO2	50	NA
	stocks		Hg	70	
Mitsui-BF process	Carbon bed absorption	Several installation	NOx	60-80	
Marsulex	with regeneration	oversees	SO2	80-99	$110-140/kw
	NH3 injection for NOx		Hg	85-90	
	control		PM	<15mg/Nm3	
GSA	CFB Absorber with	Commercial	SO2	>95	
FLSmith/Airtech	lime injection	largest unit to date is	SO3	>95	$150/kw
		125MW	Hg	50-90	

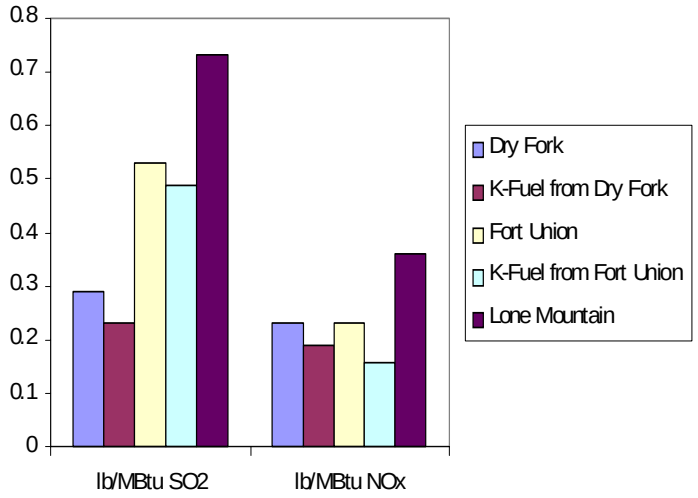
NOx-SO2-Hg

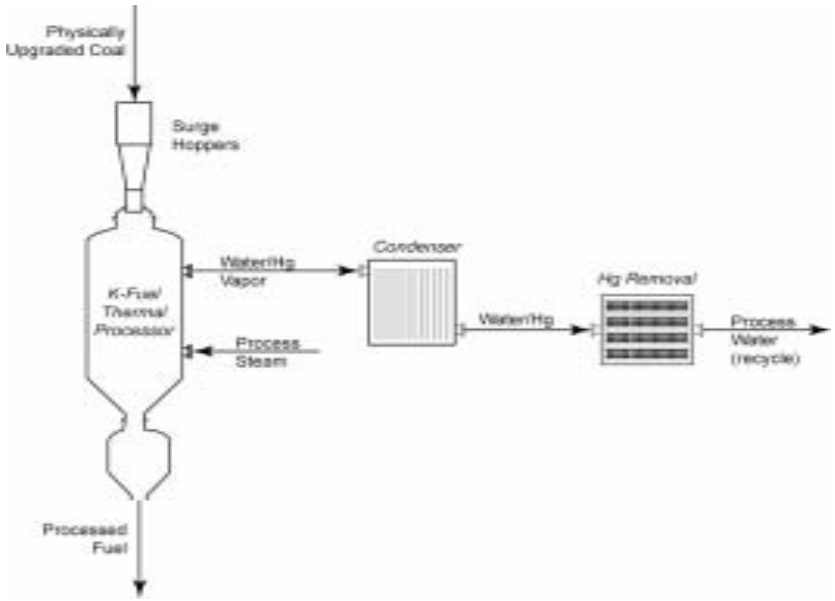
Electro-Catalytic Oxidation™ (ECO)

source - EPA

- Process
  - Barrier discharge reactor oxidizes gaseous pollutants
  - Products of the oxidation are captured in ammonia scrubber and wet ESP
  - Ammonium nitrate and sulfate (fertilizers) byproducts
- Status
  - Pilot scale test at approximately 2-4 MW equivalent
  - Projected reductions: 90, 98+, 80-90, and 95% of NO_x, SO_2, Hg, and fine PM
  - DOE-sponsored testing to evaluate mercury removal performance

K-Fuel®





- **K-fuel is a beneficiated coal derived from western subbituminous coals that is lower in ash, higher in BTU value, and produces lower pollutant emissions than parent coals.**
- **Test burns at the SRI - significant reductions in NOx and SO_2**
- **First commercial plant being built at the Black Thunder mine in Wright, Wyoming; completion by 2004; capable of producing more than 700,000 tons per year of K-Fuel**

“New" technology paradigm shift

- **In the not so distant past, new technologies came in to the market place mainly with increasingly higher performance attributes (e.g. SCR “better” than SNCR “better” than LNBs)**
- **Today “commercial” technologies can give us 90+% reductions on NOx, SO2, PM, (even Hg ???) emissions**
- **Hence, “new” technologies must find other arguments to compete**
- **Such “arguments” are more difficult as compliance dates are nearer, environmental regulations are confusing, wholesale power market dynamics are evolving (deregulation…), fuel (gas) options exist, new generation technologies (IGCC) become alternatives…**

Technology vendors today must not only develop “good” products but also “market” them successfully

Technology “consumers” must be ever more educated to be able to make good technology decisions

Less incentive for technology “push” from environmental community

An example

Compliance with regulations in the Northeast

Background

- Environmental requirements for coal-fired plants (*state regulations – post OTC NOx budget, title IV*)
  - Multi–pollutant
  - 2006 compliance
    - Must minimize R&D risks

- The Station
  - Real Estate constraints
    - Configuration options reduced

Environmental Requirements

- **The regulations**
  - **Multi-pollutant controls**
  - **Compliance 2006**

- **NOx - 1.5 lb/MWh (~55% reduction from SNCR)**
  (~75% reduction from LNBs)

- **SO2 - 3.0 lb/MWh (~75% reduction)**

- **CO2 - 1800 lb/MWh**

- **Hg - 85% - 95% (two phases)**

The Station

- Large ESPs (>450 SCA)
- Other performance information
  - NOx: 0.45-0.55 lb/Mbtu (w/o SNCR)
  - ~0.3 lb/Mbtu (w/ SNCR)
  - SO2: <1.2 lb/Mbtu
  - Hg: 80-90% capture (baseline)
    - ICR phase III participant
    - MA Hg test program (2000-2002)
    - DOE Hg control full-scale demo
  - Carbon-in-ash: 20-30%

The Station (cont'd)

Summary…

- Older vintage, small units, space-constrained plant
  - Some technical options not viable/economic
- "Neighborhood" challenging for power plant
  - technical choices must be "compatible" w/ political realities
- Baseline emissions low
  - Important consideration for overall compliance strategy

Options

- Conventional, individual unit technologies
  - SCR
  - FGD (wet or dry)
  - Hg Sorbent injection
- New multi-pollutant technologies
  - Powerspan
  - Airborne
  - Enviroscrub
- “Hybrid” innovative application of commercial technologies

Proposed Project

- **Emission Control Technologies**
  - NO_x control using clean-side SCR
  - SO_2 control using SDA
  - PM control using existing ESPs and new FF
  - Acid gas control using the SDA and new FF
  - Mercury control using the SDA/FF (ACI if necessary)
- **Multi-pollutant Control**
  - Single pollution control train for multiple emissions from three three coal units
- **Byproduct Utilization, Treatment and Disposal**
  - Fly ash beneficiation with integrated mercury control technology
  - The FF may allow reuse of SDA byproducts
- **Bottom line…**
  - Technology risk and tight schedules favored “certainty” of commercial technologies

Summary

- Regulatory and market dynamics no longer afford “easy” decisions
- Approaching technology limits changing criteria for technology decisions
- Pace of technology innovation tied to market perception.
  - Industry reacts to certainty!

Let’s go learn the latest in NOx control!!!

Thank you!

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