

REINHOLD ENVIRONMENTAL Ltd.



**2013 NO_x-Combustion Round Table
& Expo Presentations**

February 18 & 19, 2013, in Salt Lake City, UT / Hosted by PacifiCorp

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Non-Traditional and Developing NOx Control Technologies

Bob Crynack, FMC Environmental Solutions

Reinhold Environmental NOx/Combustion
Round Table

February 18-19, 2013

Technologies

- Hamon: ReACT
- FMC: PerNOxide
- Eco Power Solutions: Comply 2000
- Tri-Mer: UltraCat
- APTECH: Clean Stack Technologies
- DuPont/Belco: LoTOx

Advanced multi-pollutant control technology



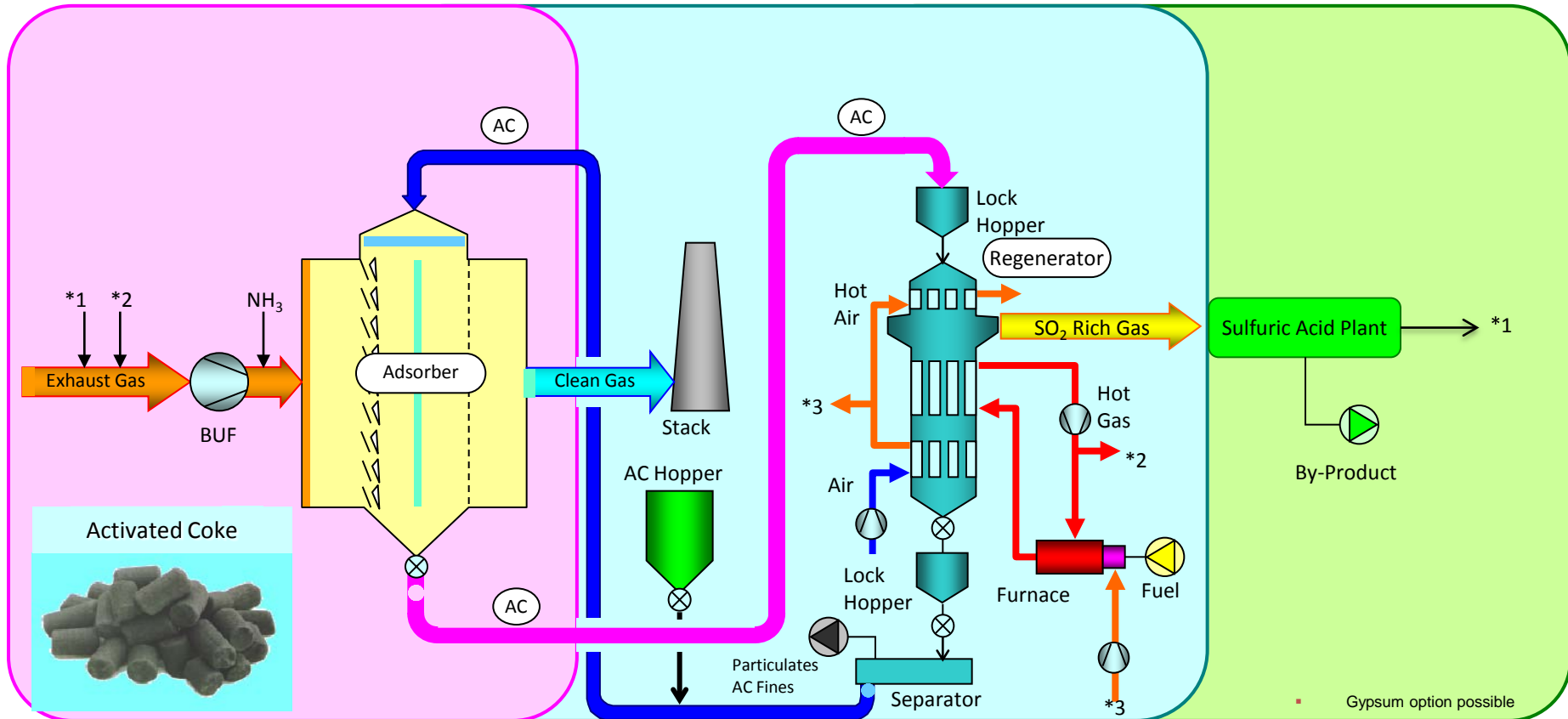
- **Proven large scale utility operation**
 - J-Power Takehara (1995) and Isogo 2x600MW (2002, 2009)
 - Isogo performs near levels required by MATS for new coal-fired EGU
 - Technical enhancements of ReACT can meet new EGU MATS
- **EPRI demonstration at Valmy station**
 - **Reliable high efficiency performance (MEGA 2008)**
 - >98-99% SO₂
 - >98-99% SO₃
 - >98-99% Hg
 - 20-50% NO_x (co-benefit)
- **Wisconsin Public Service/Weston 3**
 - **368 MW ReACT project**
 - Consent decree finalized with EPA in January 2013
 - WI PSC hearings for construction authorization January 2013
 - Permits with WI DNR in final negotiations.
 - Hamon Research-Cottrell engineering system under LTNP
 - April 2013 target for full release

ReACT™ System

Adsorption

Regeneration

By-Product Recovery



- Balance of plant systems not shown
 - Ammonia supply
 - Nitrogen

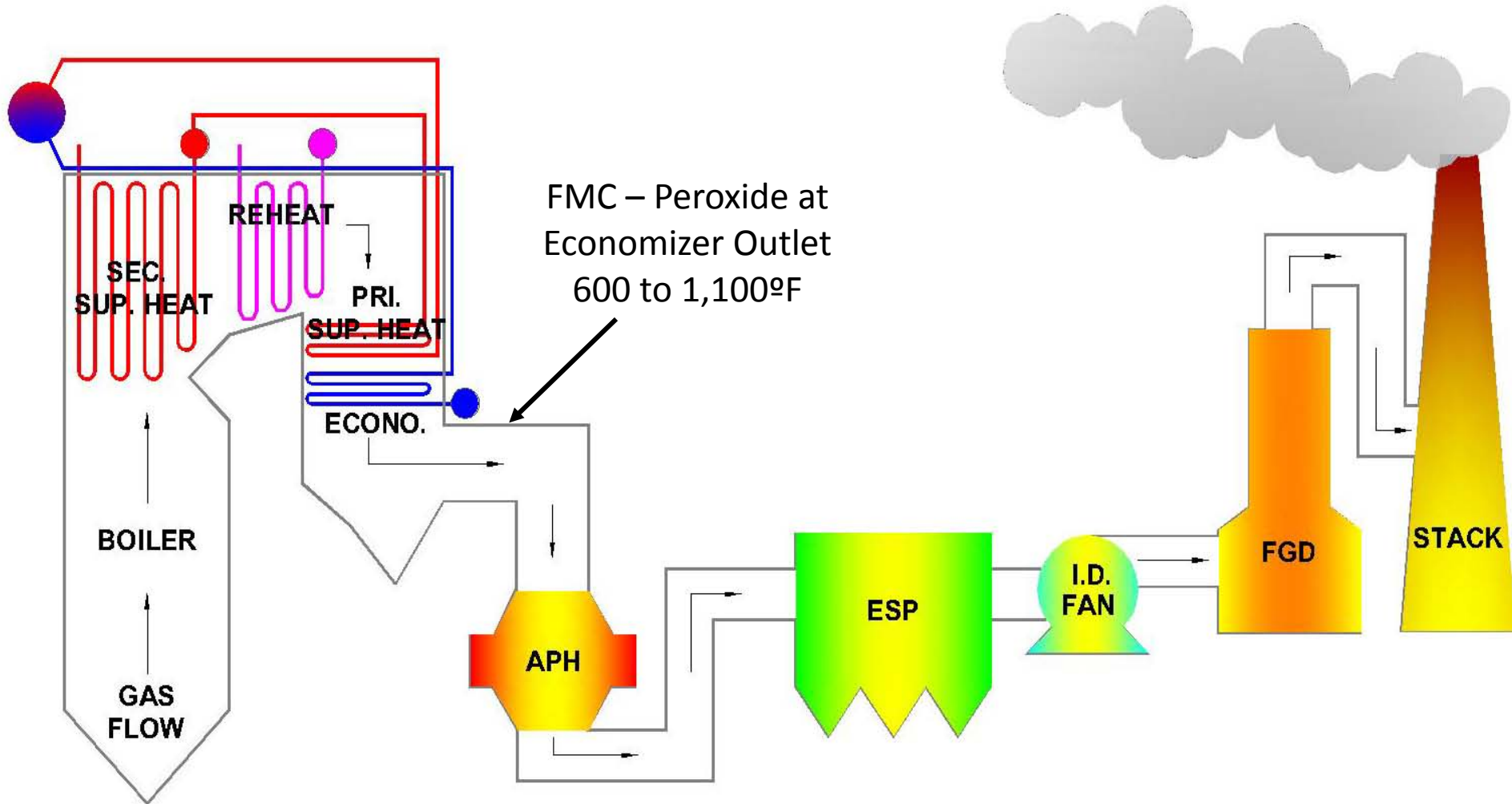
ReACT Process

- Activated coke provides catalytic surface and functional sites for NO_x reduction in the presence of ammonia.
- NO_x control activity is completed in the adsorber.
- $\text{NO} + \text{NH}_3 + 1/4 \text{O}_2 \rightarrow \text{N}_2 + 3/2 \text{H}_2\text{O}$
- $\text{NO} + \text{C..R} \rightarrow \text{N}_2$
(C..R represents a surface functional site)
- Up to 50% NO_x reduction

FMC PerNOxide

- Based on NASA patent to use H₂O₂ to oxidize NO to water soluble N species that can be captured in downstream SO₂ scrubber
- FMC has exclusive rights to patent
- FMC partnered with URS for development, commercialization, and implementation
- Up to 70% NO_x reduction
- Not yet commercial

NO_x Control Options - Oxidation



Injection Lances

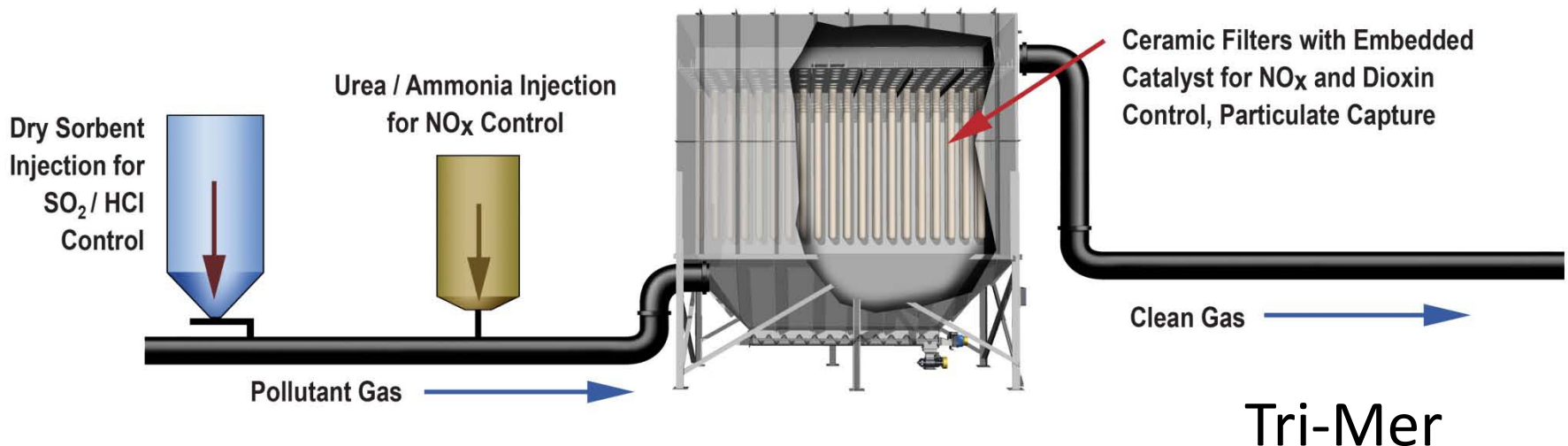


Comply 2000

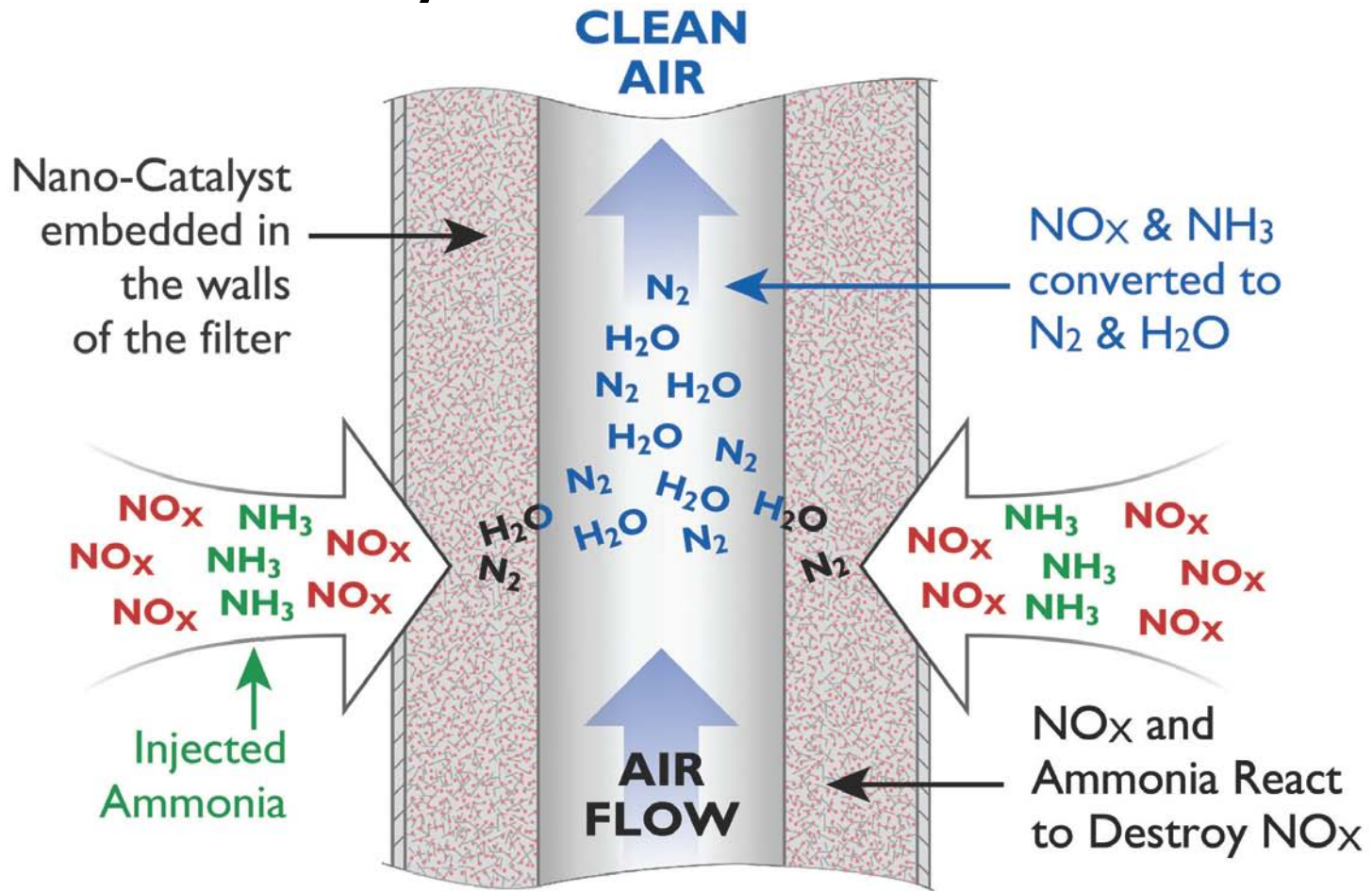
- Multi pollutant control
- Reactor module
 - Multiple fogging stages
 - Combination of O₃ and H₂O₂ for oxidation
 - Packing
 - Mist eliminators
 - Activated carbon filters

NO_x removal – low temp nanocatalyst & ammonia injection

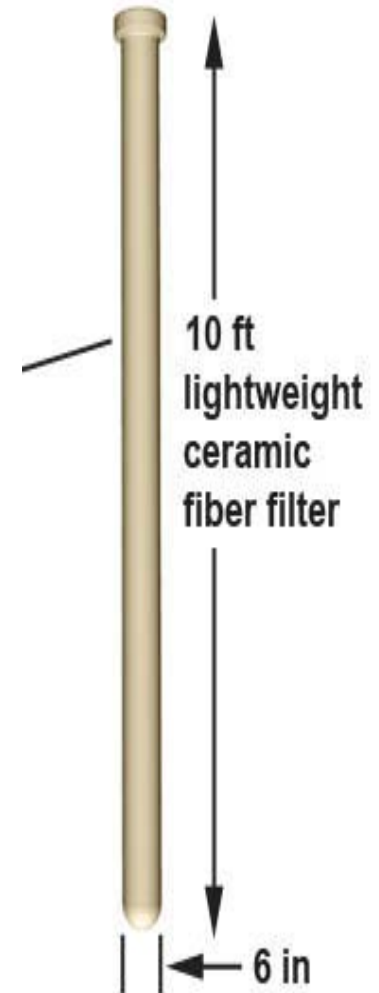
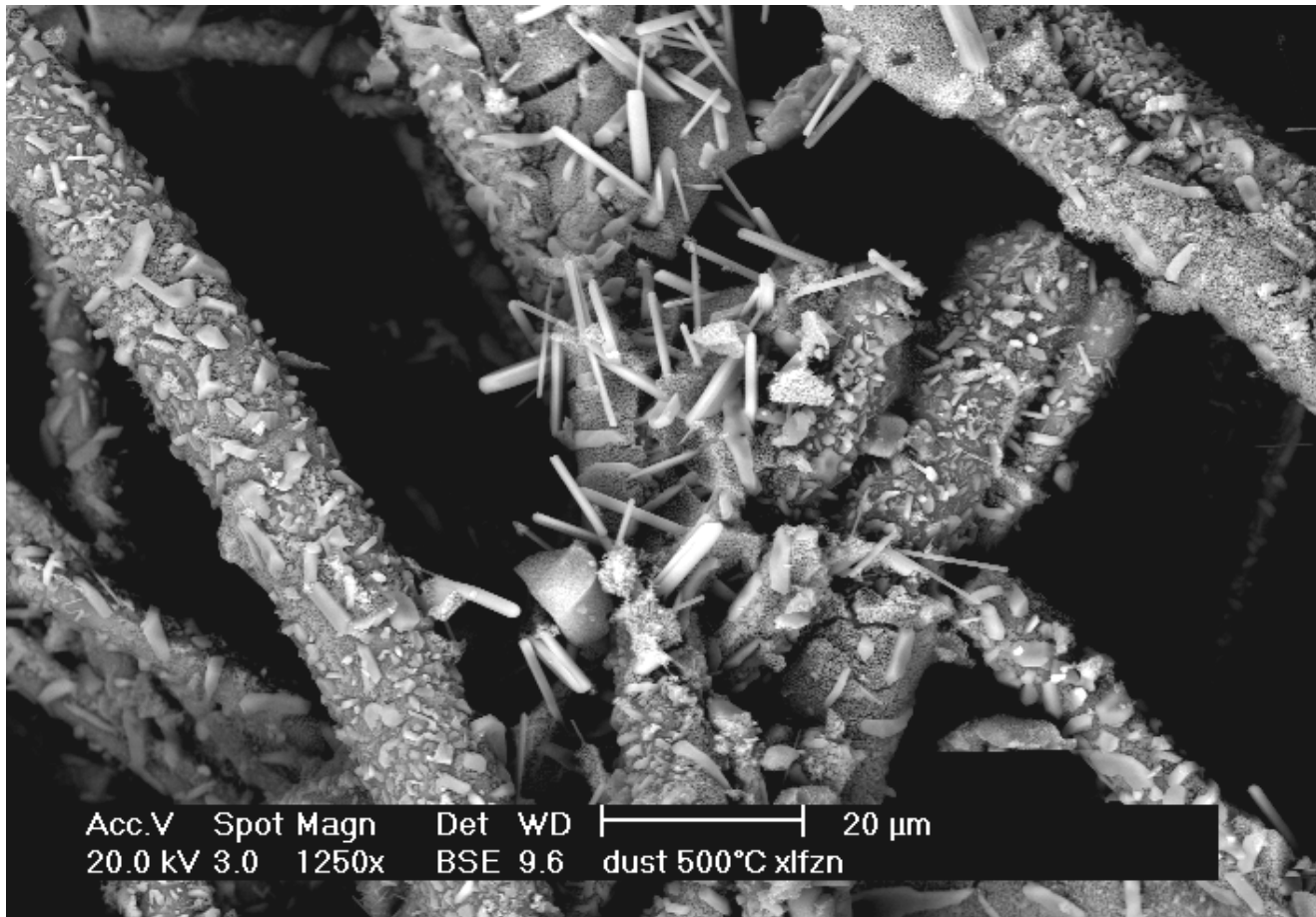
- UltraCat Catalyst Filters preceded by upstream ammonia injection
 - ❖ Selective Catalytic Reduction (SCR) with proprietary catalyst
 - ❖ Catalyst formulation much less sensitive to SO₂ → SO₃, HCl
- UltraCat Catalyst Filter performance: up to 90% removal of NO_x
 - ❖ Operating temperature range 350 F – 750 F



Ammonia injection with Nano-catalysts in filter walls



UltraCat catalyst filter for PM +SO₂/HCl+NO_x



Nano-bits of NO_x catalyst are embedded within the fibers
and on the fibers

Generalized Arrangement

NOTE: several variations are possible

Sorbent kept encased in water droplets until the flow reaches the SH/RH. Water prevents sorbent from sintering

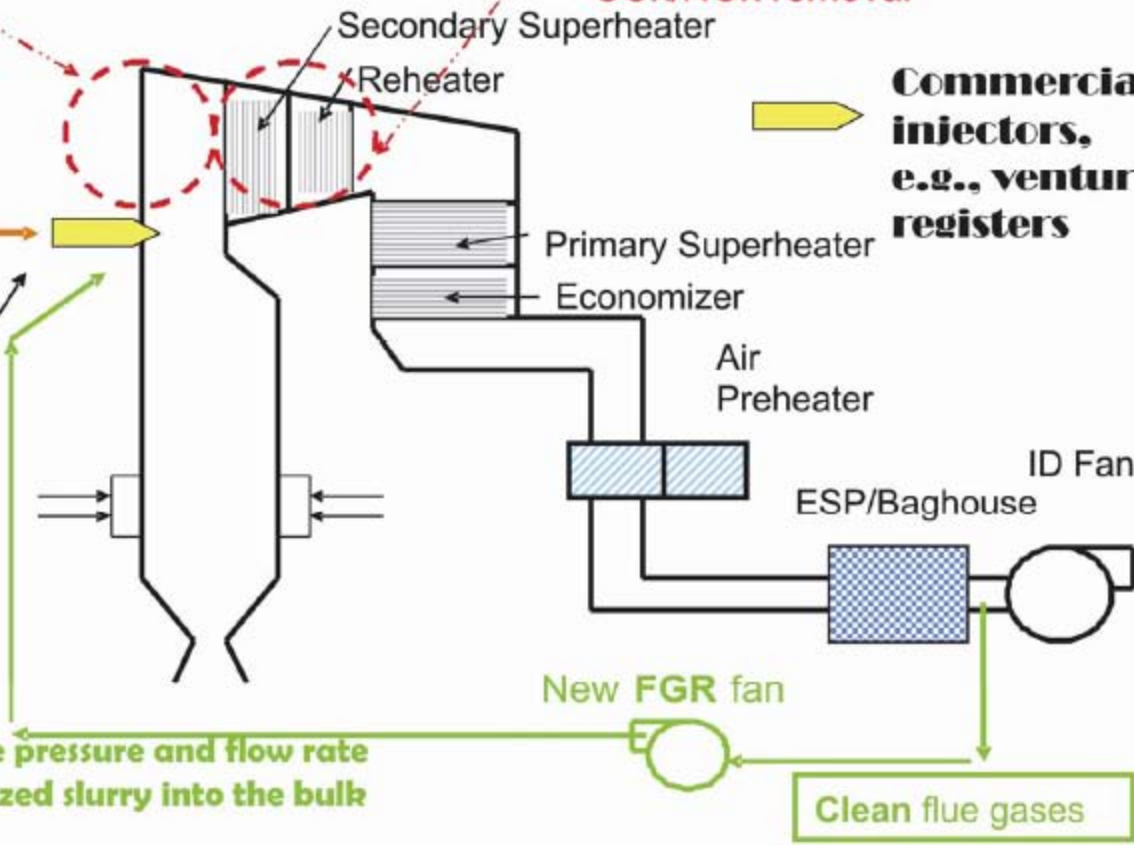
Dry sorbent reaches zone of optimum temperature for SO_x/NO_x removal

Water slurry of reagents – pulverized limestone, urea, etc.

Compressed air for slurry atomization

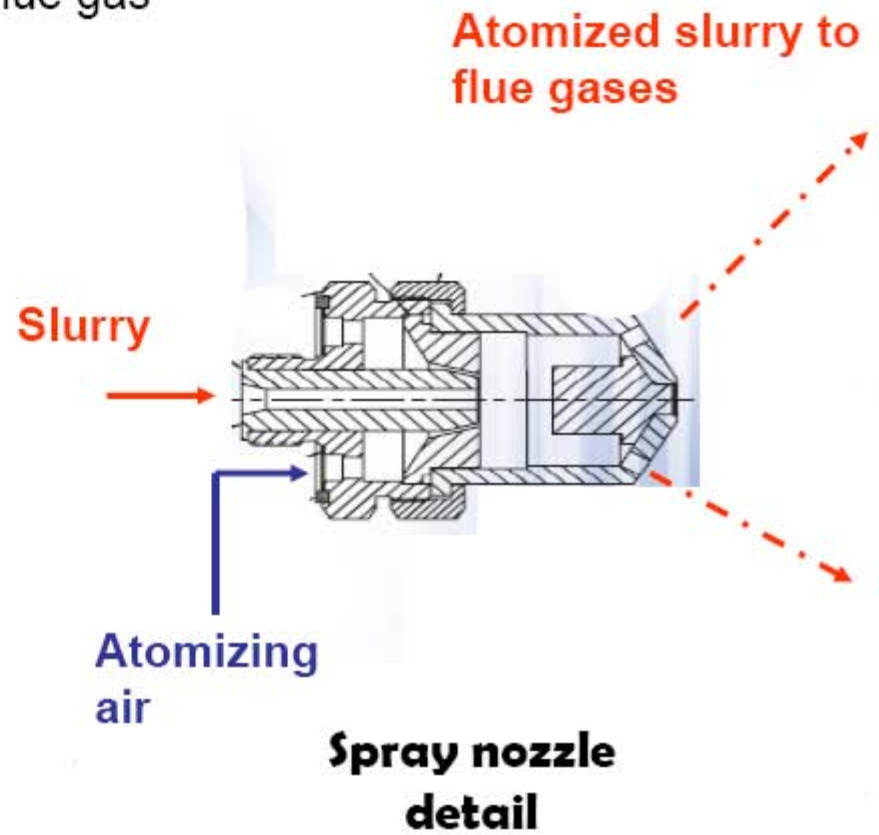
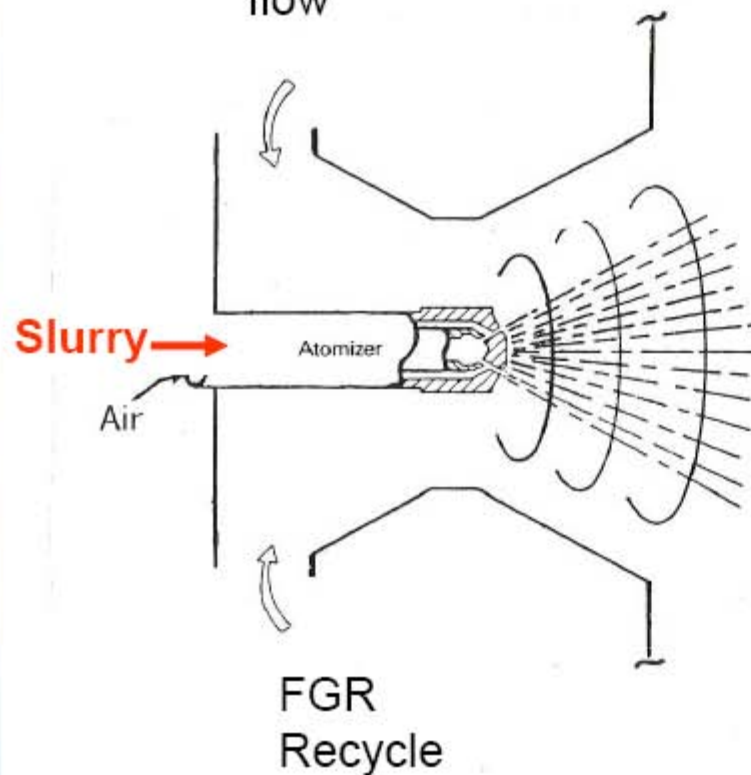
FGR gases at adequate pressure and flow rate convect and mix atomized slurry into the bulk furnace flow

Commercial injectors, e.g., venturi registers



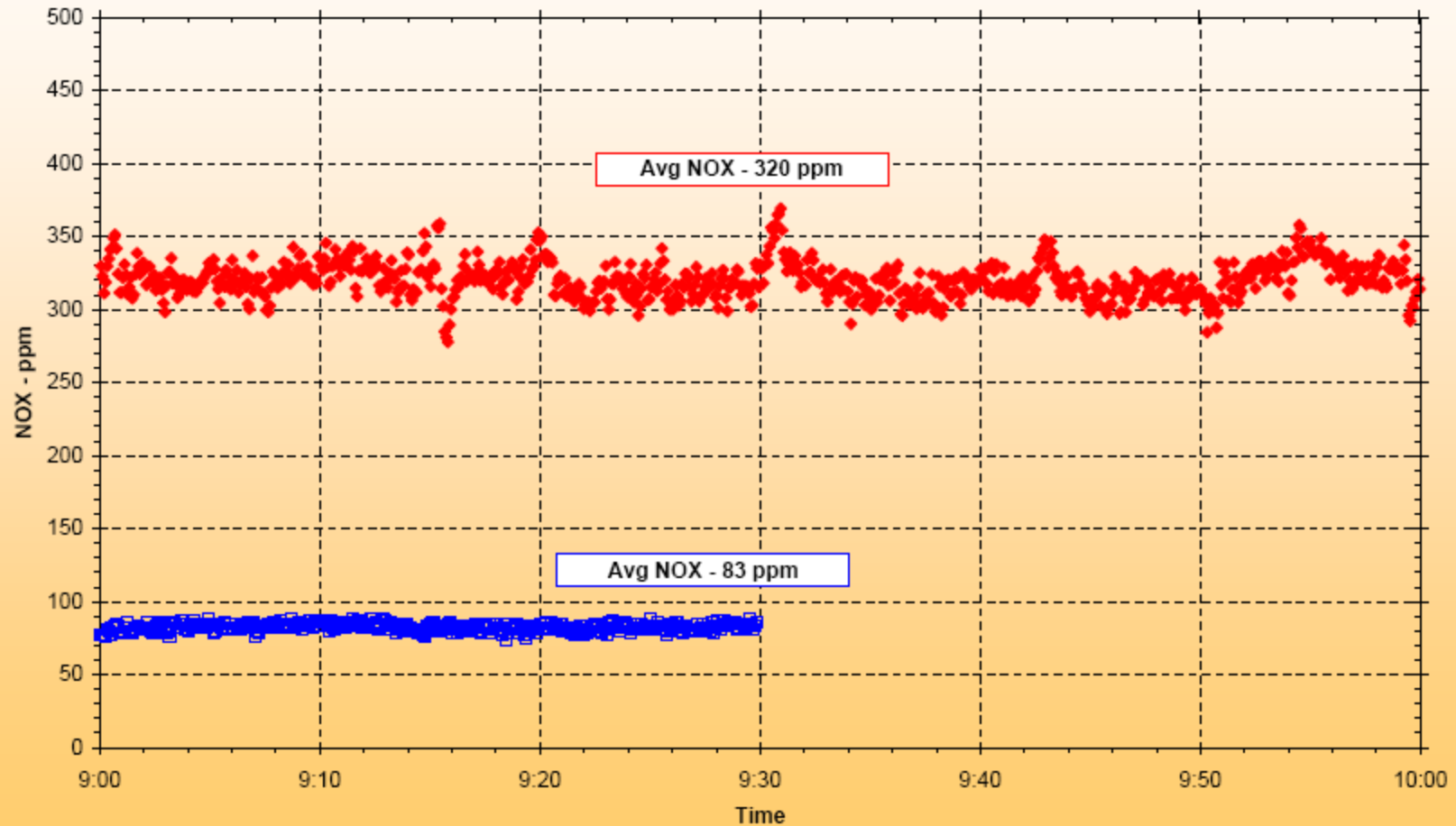
Slurry Atomization and Injection

FGR Recycle used to convect the atomized slurry into the bulk flue gas flow



PRB NO_x Reduction

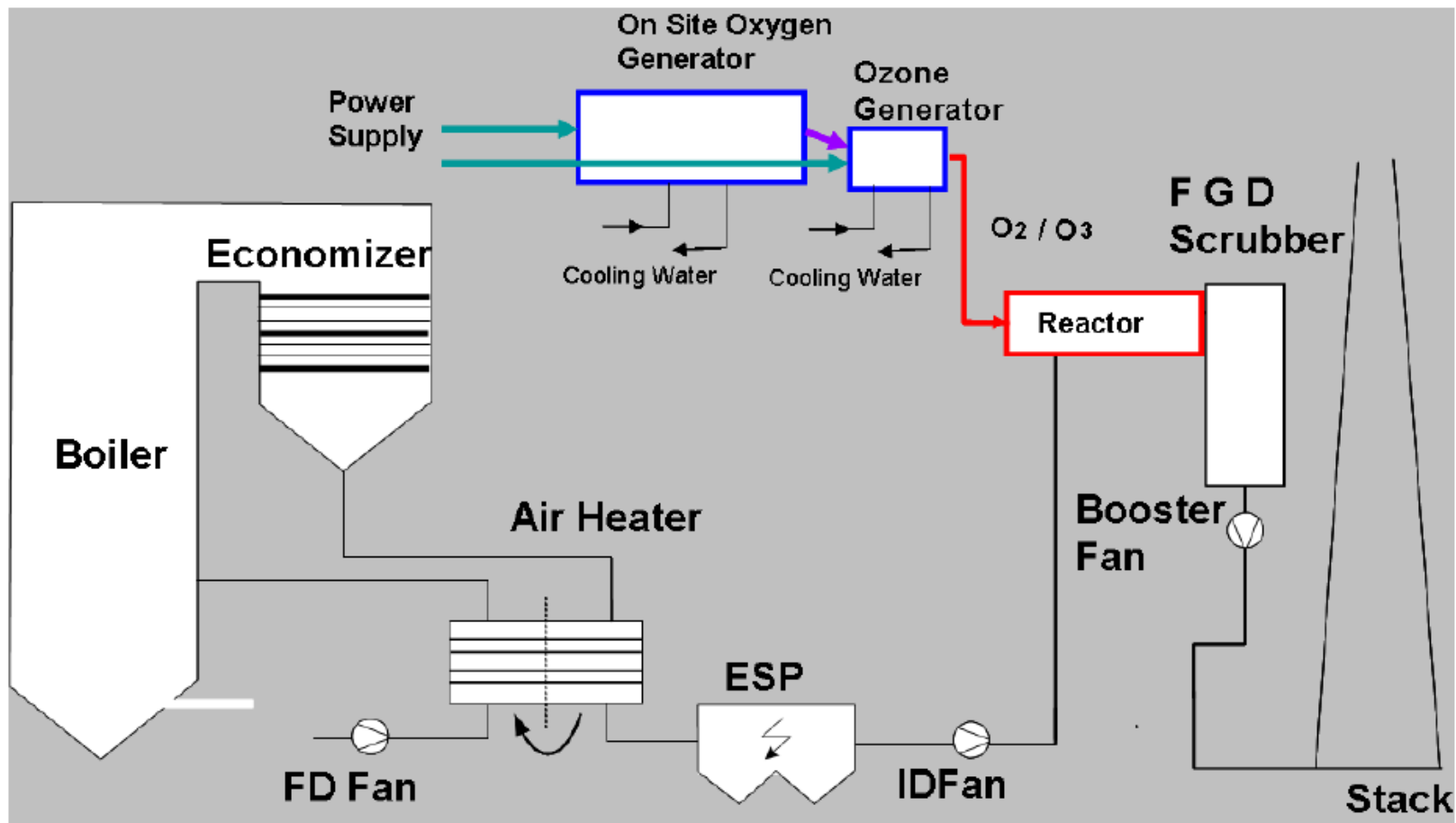
Comparison Between Baseline Data and Urea Injection on PRB Coal
January 18, 2008



DuPont/Belco LoTOx™

BOC/Linde's LoTOx™ System has provided 90+% NOx removal at several installations:

- A gas fired boiler, 90% NOx removal to 4 ppm
- An acid pickling process, 95% NOx removal to 100 ppm
- A 25 MW coal fired power plant, >90% NOx removal to 10 ppm
- A 25,000 SCFM metals furnace, 90% NOx removal to 10 ppm
- Several demonstrations, including coal fired power plants & refinery FCCUs



- Thanks to the companies that provided information for the presentations
- Questions?????