

Reinhold Environmental Ltd.



2008 NOx-Combustion Round
Table & Expo Presentation

February 4-5, 2008 in Richmond, VA

Flow Modeling of SCRs

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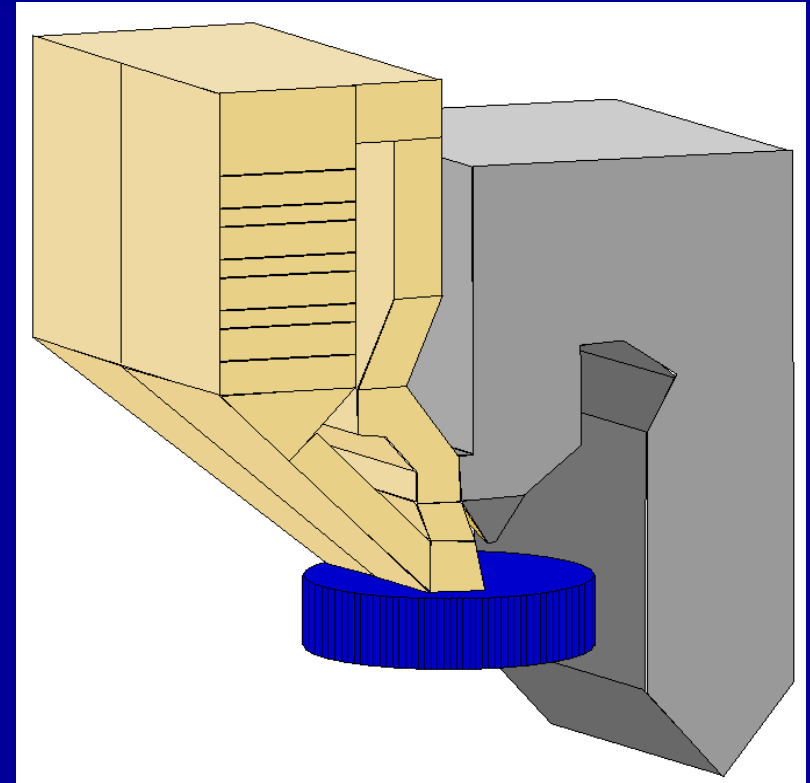
Why is Flow Distribution Important to SCRs?

❖ Performance

- Gas velocity uniformity
- Uniform NH_3 -to- NO_x ratio
- Thermal mixing
- Ash capture / build-up

❖ Operating costs

- Pressure drop
- Erosion
- Corrosion



Fluid Dynamic Design Methods

❖ Physical Flow Modeling

- Lab representation of geometry
- Typical scale 1:8 to 1:16
- “Cold flow” modeling
- Visualize flow with smoke
- Simulate ash deposition
- Measure flow properties
 - Velocity
 - Pressure
 - Tracer gas



Typical 1/12 scale physical model

• Turning vanes

• AIG w/static mixers

• Economizer bypass

• Economizer outlet

• LPA screen

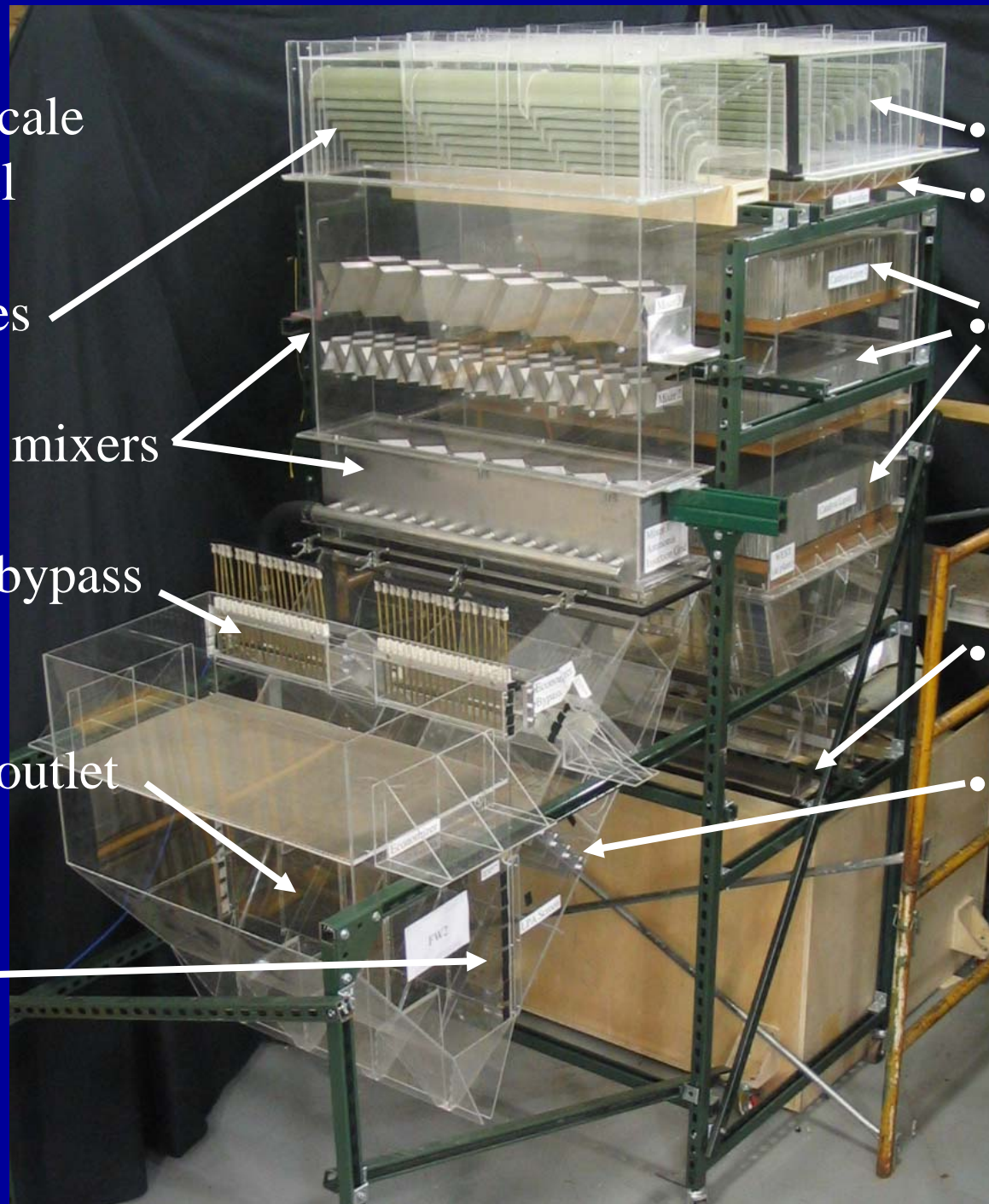
• Vanes

• Rectifier

• Catalyst layers

• Air heater

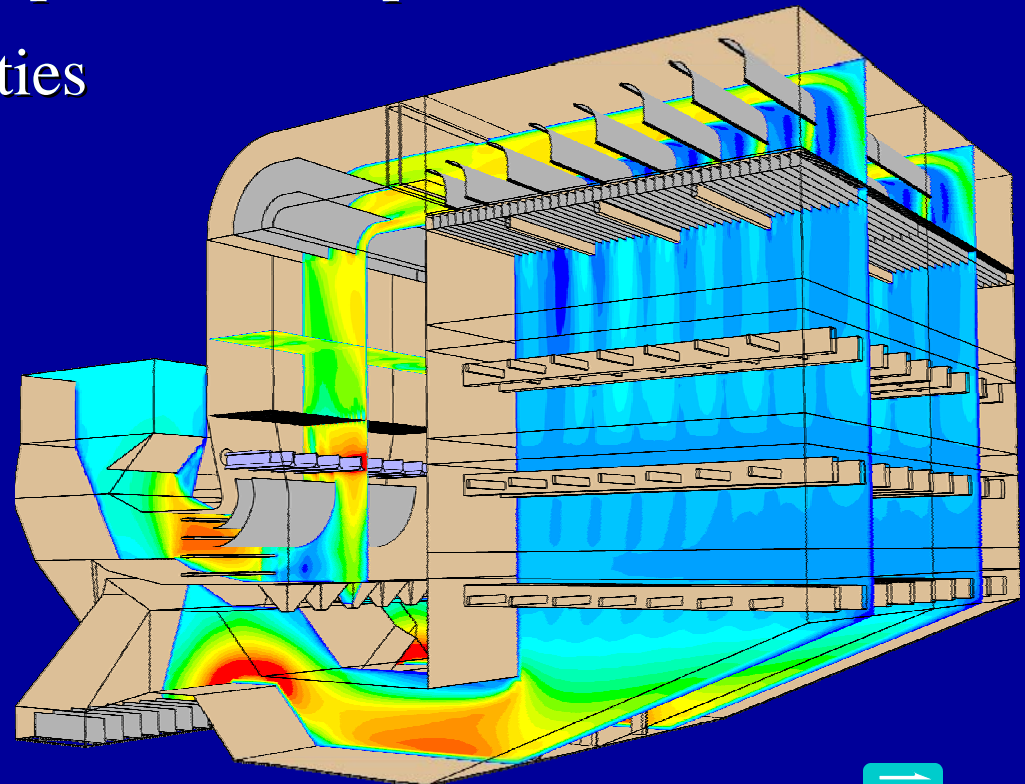
• Dampers



Fluid Dynamic Design Methods

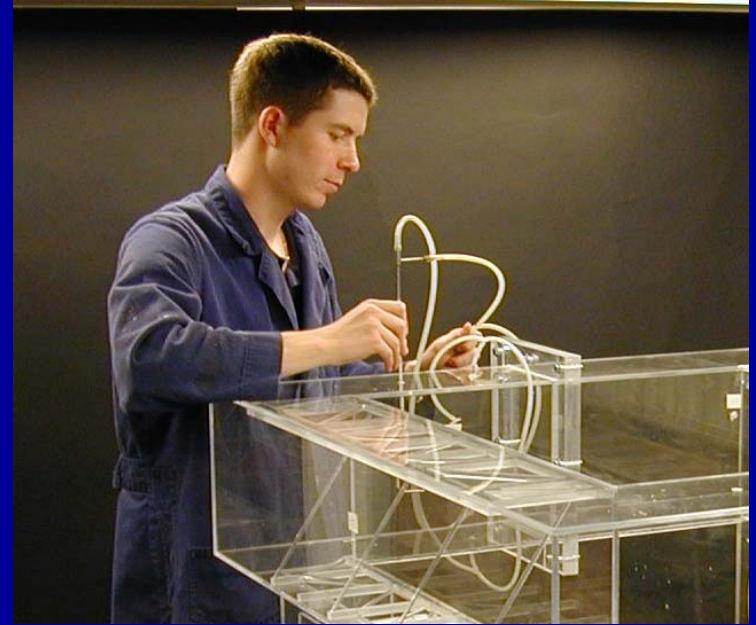
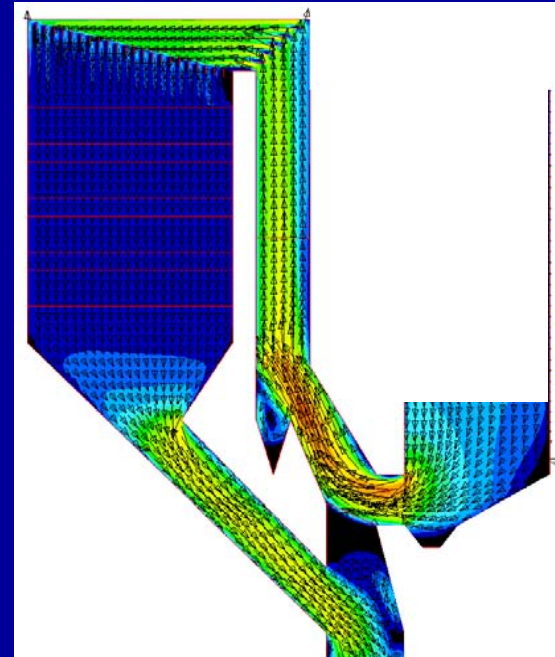
❖ Computational Fluid Dynamics (CFD)

- Numerical simulation of flow
- Utilize high speed computers and sophisticated software
- Calculate flow properties
 - Velocity
 - Pressure
 - Temperature
 - Ammonia
 - Particle streamlines



SCR Performance Goals

- ❖ Uniform velocity
- ❖ Uniform temperature
- ❖ Uniform NH_3 -to- NO_x ratio
- ❖ Avoid ash build up, LPA carryover
- ❖ Minimize DP



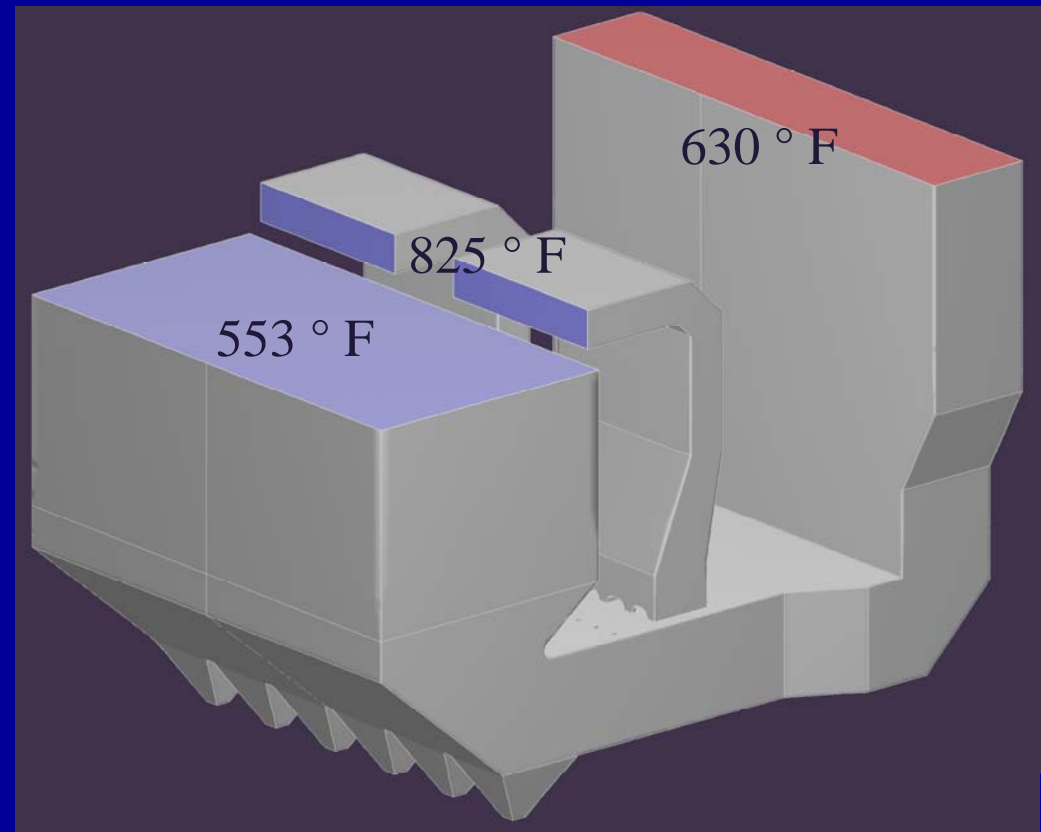
SCR Velocity Distribution

- ❖ Velocity profile
 - At AIG
 - At SCR inlet
 - At AH inlet
- ❖ Directionality
 - At SCR inlet



SCR Thermal Mixing

- ❖ Economizer gas bypass used to boost SCR inlet gas temperature under low load operation
- ❖ Extract hot gas at econ inlet
- ❖ Inject into cooler econ outlet stream
- ❖ Sounds simple enough, but there are many options and competing design elements



Without mixer, $\Delta T = \pm 83 \text{ }^\circ\text{F}$

With mixer, $\Delta T = \pm 15 \text{ }^\circ\text{F}$

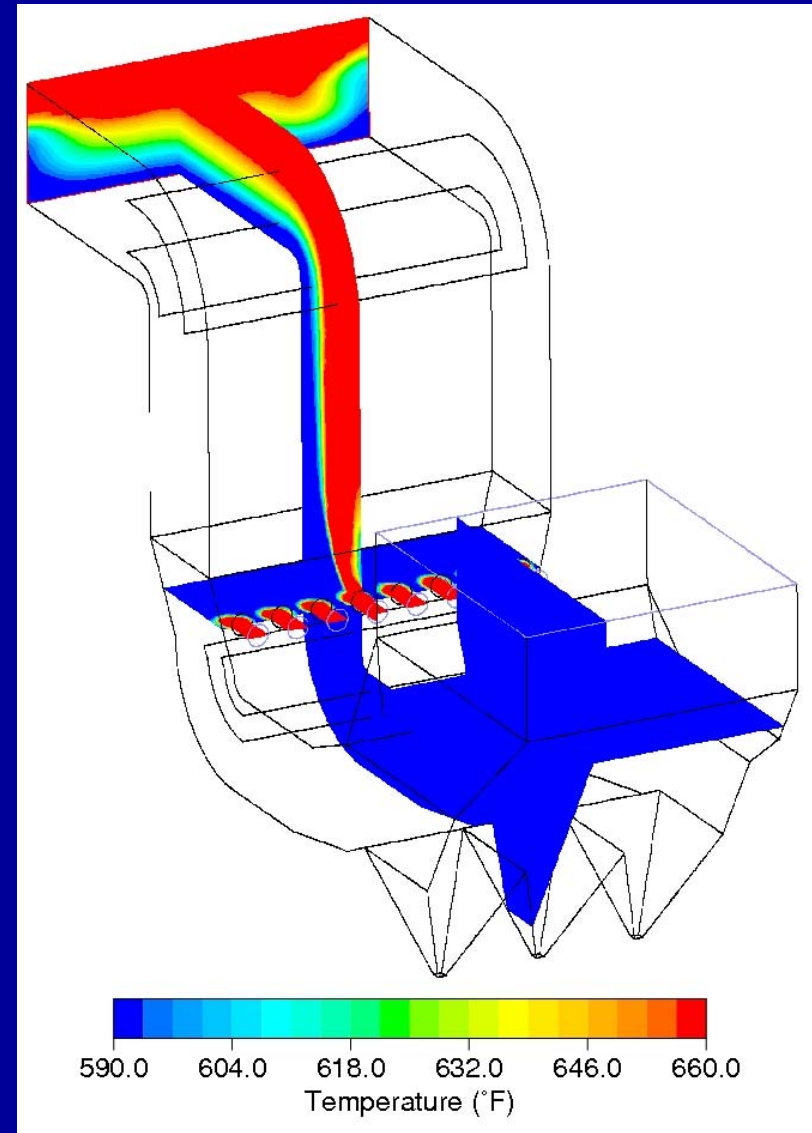
Case Study – IPL Harding Street Unit 7

- ❖ Catalyst design temperature 630 °F
- ❖ Economizer bypass required for low and mid load operation
- ❖ Mixing goal: ΔT at catalyst ± 20 °F
- ❖ Initial design of economizer bypass ductwork
 - Two 5'x5' takeoffs in backpass
 - Split to sixteen 18" pipes



Case Study – IPL Harding Street Unit 7

- ❖ Baseline CFD runs indicate bypass flow is well distributed East-West, but not North-South
- ❖ Low Load ΔT at catalyst ± 120 °F
- ❖ Bulk static mixer not desired
- ❖ Mixer designed at hot gas injection point to reduce North-South gradient



Case Study – IPL Harding Street Unit 7

- ❖ Mixer elements based on patented design
- ❖ CFD runs performed to optimize thermal mixing with minimum full load pressure loss
- ❖ ΔT at catalyst ± 20 °F

