An Economical Alternative for HRSG SCR Reagent Supply
FUEL TECH SOLUTIONS

FUEL CHEM®
- Boiler efficiency, slag and corrosion reduction, SO₃ abatement
- TIFI - Targeted In-Furnace Injection technology
- Focus is on clean, efficient energy and fuel flexibility
- Full service operating programs include reagent, equipment, analysis and field support

Air Pollution Control (APC) Systems
- NOₓ control focus to meet federal and state regulatory requirements
- Full spectrum of NOₓ control technologies including burner technologies, SNCR and SCR
- Capital project sale, typically fixed price and often turn-key
- Guaranteed performance
- Systems installed on over 700 units worldwide
- Aftermarket Services for all product lines
Office Locations: Warrenville, IL | Stamford, CT | Durham, NC | Milan, Italy | Beijing, China

Countries where Fuel Tech does business: USA, Belgium, Canada, Chile, China, Columbia, Czech Republic, Denmark, Dominican Republic, Ecuador, France, Germany, India, Italy, Jamaica, Mexico, Poland, Portugal, Puerto Rico, Romania, South Korea, Spain, Taiwan, Turkey, United Kingdom, Venezuela
Proprietary Software with Strong IP Protection; Patented Technology

- Determines chemical injection location and quantity (i.e., the right amount at the right place within the right temperature zone)
- Basis for performance guarantees

Computational Fluid Dynamics (CFD) Model

- Customized for each boiler
- Predicts flow path, velocities and temperatures

Chemical Kinetics Modeling

- Predicts chemical reactions along a specific flow path

Cold Flow Modeling

- Highly accurate physical models that replicate gas flows, injection patterns, etc.
- Durham, NC office has capabilities to build 1/12 scale models to correlate with CFD models to optimize designs
HRSG SCR

CONTINUOUS EMISSIONS MONITOR (CEMS)

NOx CATALYST

CO CATALYST

CONTROL ROOM

AQUEOUS AMMONIA STORAGE TANK

AMMONIA FLOW CONTROL UNIT

VAPORIZER

AMBIENT AIR

BLOWER-HEATER MODULE

AIG PIPING
REAGENT CONSIDERATIONS

Anhydrous Ammonia
- Least Expensive (Coming in the Gate)
- Extremely Hazardous
- Requires RMP and Extensive Safety

Aqueous Ammonia
- 29% Conc. – Limited Availability
- 19% Conc. – Requires Greater Heat Input for Vaporization

### Table: Exposure Effects of Ammonia

<table>
<thead>
<tr>
<th>Exposure (ppm)</th>
<th>Effect on the Body</th>
<th>Permissible Exposure</th>
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</thead>
<tbody>
<tr>
<td>50 ppm</td>
<td>Detectable by most people</td>
<td>No injury from prolonged, or repeated exposure</td>
</tr>
<tr>
<td>134 ppm</td>
<td>Irritation of nose and throat</td>
<td>Eight hours maximum exposure</td>
</tr>
<tr>
<td>700 ppm</td>
<td>Coughing, severe eye irritation, may lead to loss of sight</td>
<td>One hour maximum exposure</td>
</tr>
<tr>
<td>1,700 ppm</td>
<td>Serious lung damage, death unless treated</td>
<td>No exposure permissible</td>
</tr>
<tr>
<td>2,000 ppm</td>
<td>Skin blisters and burns within seconds</td>
<td>No exposure permissible</td>
</tr>
<tr>
<td>5,000 ppm</td>
<td>Suffocation within minutes</td>
<td>No exposure permissible</td>
</tr>
</tbody>
</table>
Reagent Considerations

**Anhydrous Ammonia**
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**Urea for On-Site Ammonia Generation**
- Significant Safety Advantages
- Worldwide Commodity
THERMAL DECOMPOSITION OF UREA

Carrier Medium: Ambient Air, Clean Flue Gas

Heat Source in the Form of Burner, Electric Heat, or Hot Flue Gas

Injection of Aqueous Urea in Temperature and Time Dependent Chamber – Fast Load Following Capabilities

Urea + Time + Temperature = NH₃ + HNCO
AVAILABILITY OF UREA

Urea price is stable and competitive with NH3

Readymade Solution, or On-Site Solution from Dry Pellets
Computational Fluid Dynamics (CFD) and Chemical Kinetics Modeling (CKM) are used to determine reactor chamber design.
CASE STUDY: SYSTEM SPECIFICATIONS

- System Designed for 40% or 32% Urea (40% Initial Operation)
- 24.7 lb-NH3/hr maximum and 2.47 lb-NH3/hr minimum
- 8,000 Gallon FRP Concentrated Urea Storage Tank
- Two (2) 100% Dilution Air Blowers
- One (1) Metering and Distribution Module
- One (1) Natural Gas Burner
- One (1) Decomposition Chamber (2’ Diameter × 20’ Tall)
- Two (2) Urea Injectors
- ControlLogix PLC Controls
- Construction, Startup and Optimization Support
CAMPUS SIZE
18,000,000 Square Feet IN 150 BUILDINGS

NATURAL GAS PURCHASED
3,996,000 MMBTU

ELECTRICITY DISTRIBUTED
345,000,000 KWH

CO₂𝑒 RELEASED
220,000 TONS
ULTRA LOAD FOLLOWING PERFORMANCE

Graph showing PPM levels with different lines representing Urea Flow (GPH), Outlet NH3 (CEMS-ppm), Outlet Nox (CEMS-ppmc), and a linear relationship for Outlet Nox (CEMS-ppmc).
For more information on this case study, please see our upcoming joint paper and presentation at the 26th Annual Campus Energy Conference


UT Austin Efficiency Improvements & ULTRA System
Juan Ontiveros, University of Texas, Austin
Kevin Dougherty, Fuel Tech
## ULTRA: EXPERIENCE LIST (ABBREV.)

<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>PRODUCT TYPE</th>
<th>COUNTRY</th>
<th>OWNER</th>
<th>UNIT/LOCATION</th>
<th># of UNITS</th>
<th>UNIT TYPE</th>
<th>Boiler Size</th>
<th>UNITS</th>
<th>FUEL TYPE (PRIMARY)</th>
<th>REAGENT RATE</th>
<th>UNITS</th>
<th>ULTRA FUEL</th>
<th>ULTRA AIR SOURCE</th>
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<td>Gas</td>
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</table>
NIPSCO Bailly 8
1250 lb/hr
NIPSCO Bailly 7
720 lb/hr NH3
France, Brest MSW
18 kg/hr NH3
SUMMARY

ULTRA – ON-SITE UREA TO NH3

• Extensive Operating History
• Reliable and High Availability
• Safe & Economical Alternative to NH3
• Demonstrated Ability to Start Quickly and Follow Load
• Footprint not Typically Larger than NH3 Systems