McIlvaine Hot Topic Hour

February 14, 2013

An Economical Alternative for HRSG SCR Reagent Supply

FUEL TECH

Technologies to enable clean efficient energy

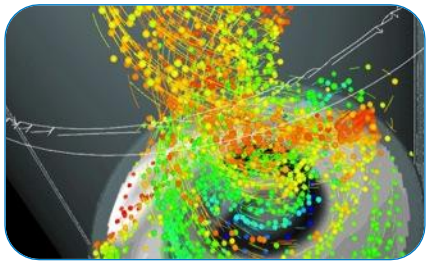
FUEL TECH SOLUTIONS

FUEL CHEM®

- Boiler efficiency, slag and corrosion reduction, SO_3 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

- NO_x control focus to meet federal and state regulatory requirements
- Full spectrum of NO_x 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




FUEL TECH'S GLOBAL PRESENCE

★ **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

MODELING FOR DESIGN AND PERFORMANCE

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

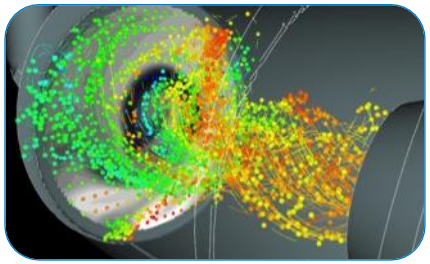
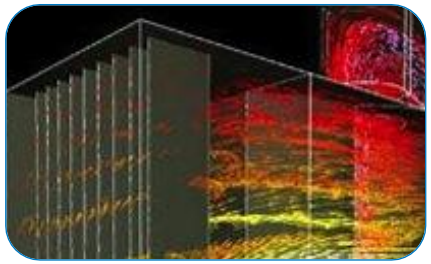
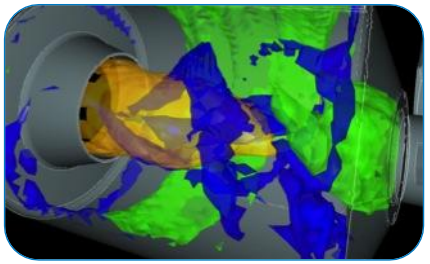
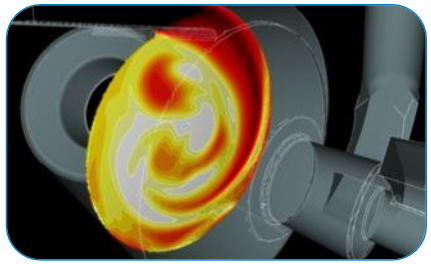
- Customized for each boiler
- Predicts flow path, velocities and temperatures

Chemical Kinetics Modeling

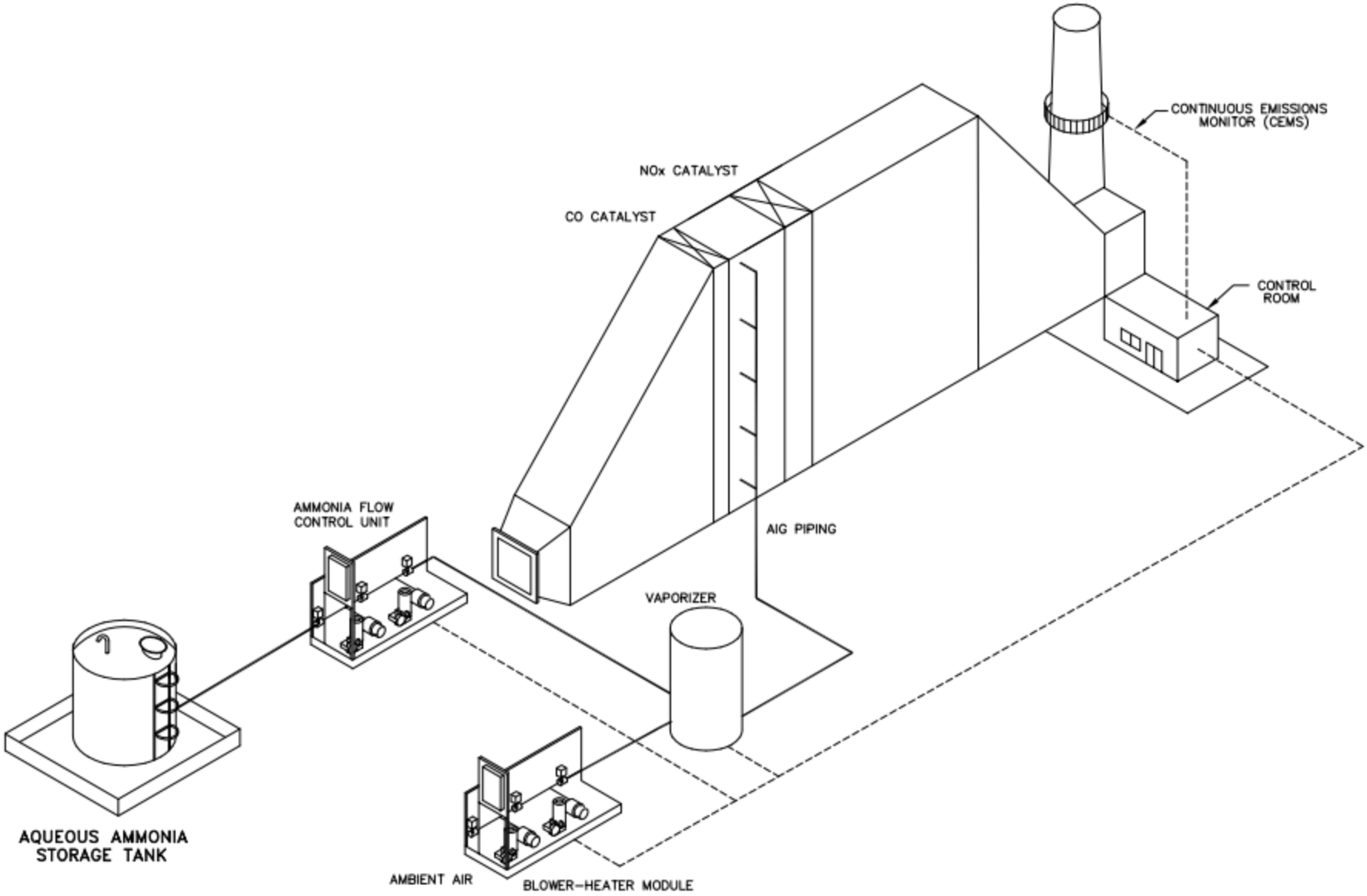
- Predicts chemical reactions along a specific flow path

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

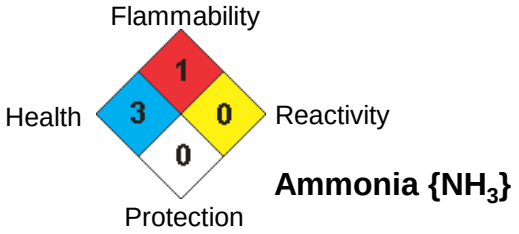
HRSG SCR


CONTINUOUS EMISSIONS MONITOR (CEMS)
NOx CATALYST
CO CATALYST
CONTROL ROOM
AMMONIA FLOW CONTROL UNIT
AIG PIPING
VAPORIZER
AQUEOUS AMMONIA STORAGE TANK
AMBIENT AIR
BLOWER-HEATER MODULE

REAGENT CONSIDERATIONS

Anhydrous Ammonia

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



Ammonia {NH_3}

Aqueous Ammonia

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

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

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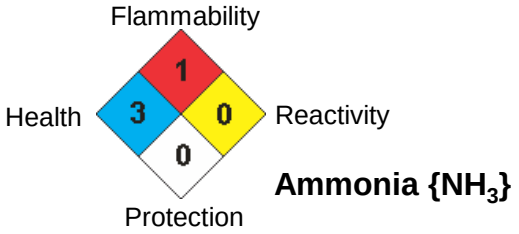

Aqueous Ammonia

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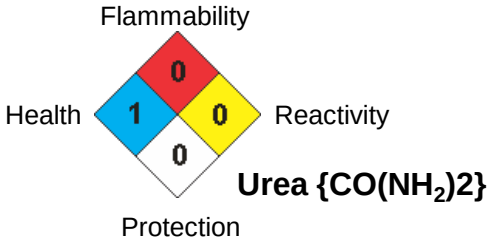
Urea for On-Site Ammonia Generation

- Significant Safety Advantages
- Worldwide Commodity

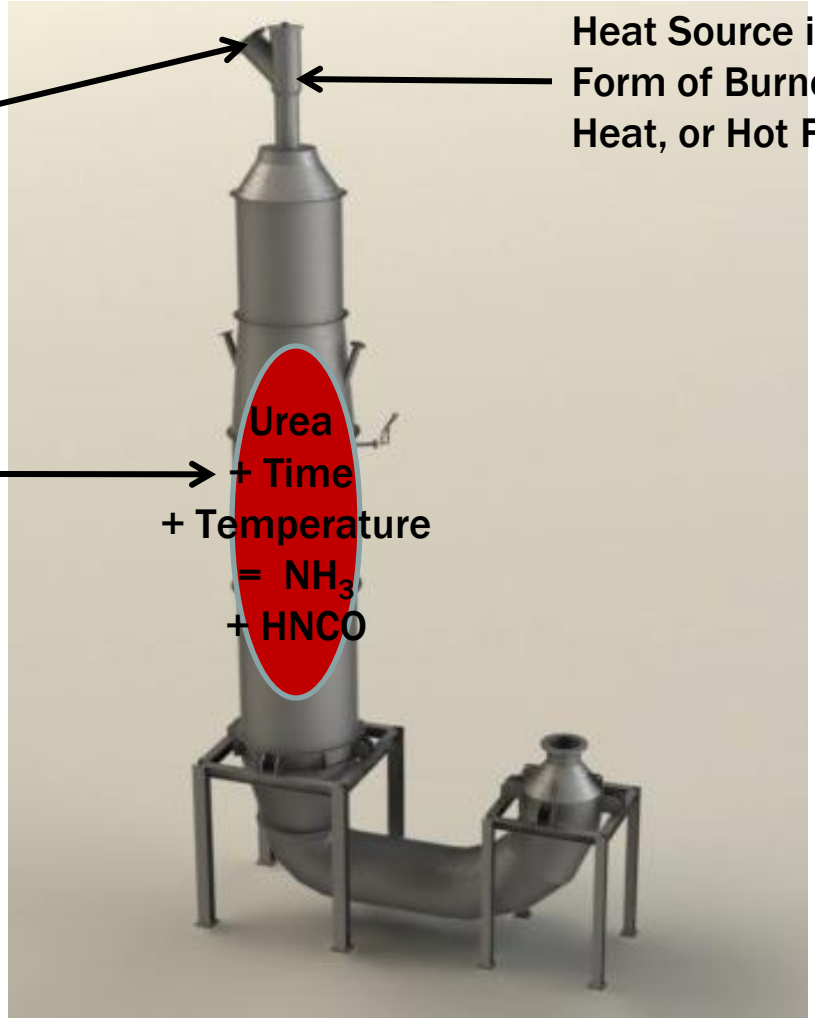


THERMAL DECOMPOSITION OF UREA

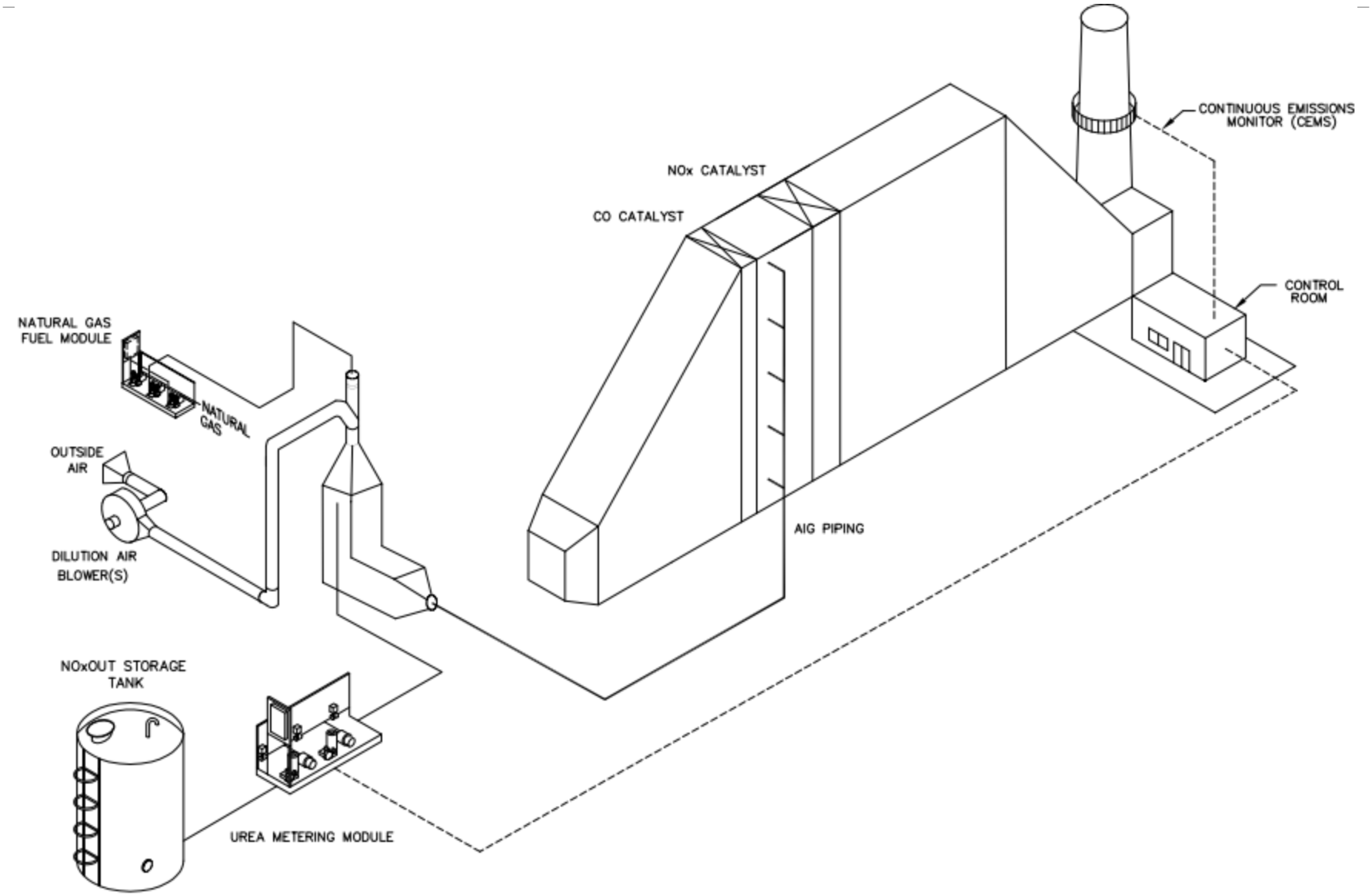
Carrier Medium: Ambient Air, Clean Flue Gas

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

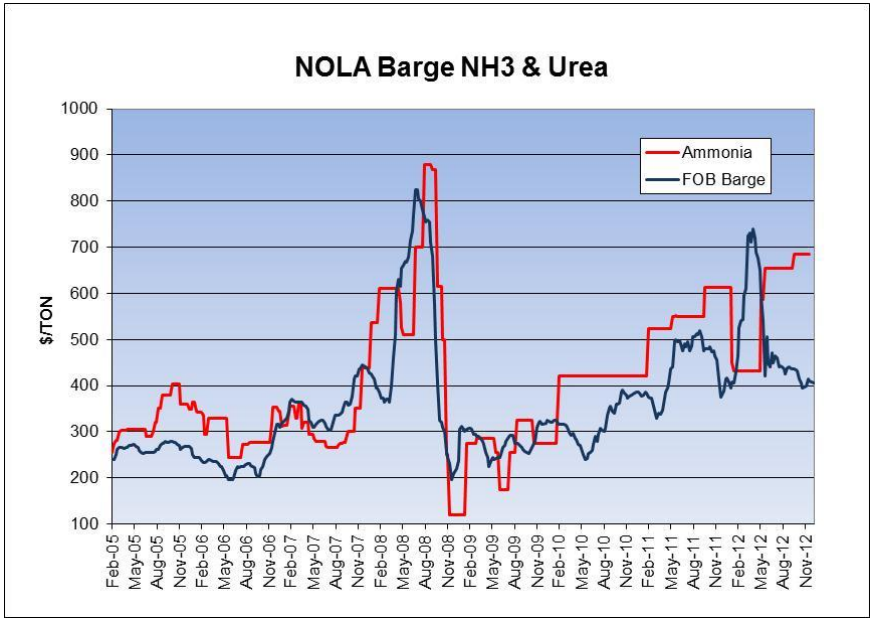


ULTRA HRSG SCR

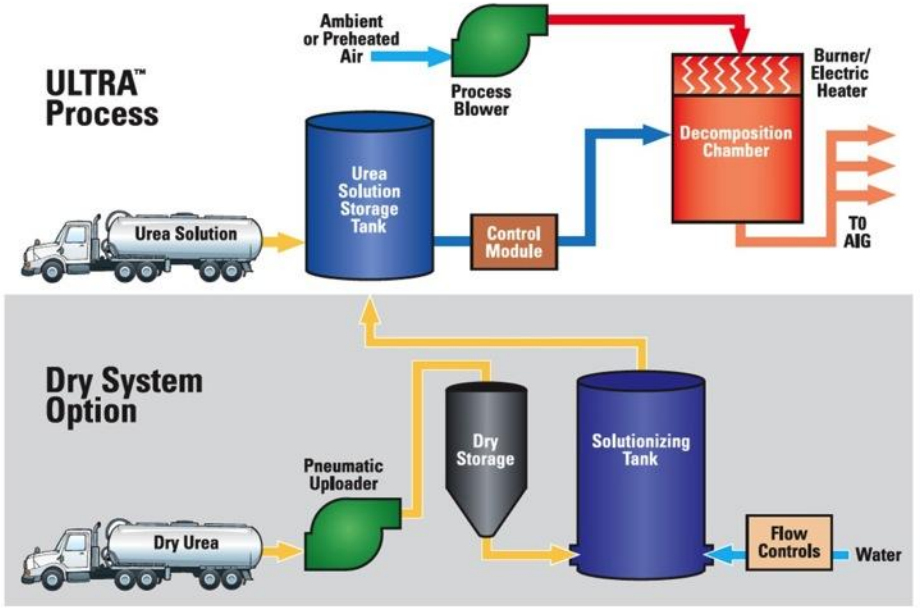


AVAILABILITY OF UREA

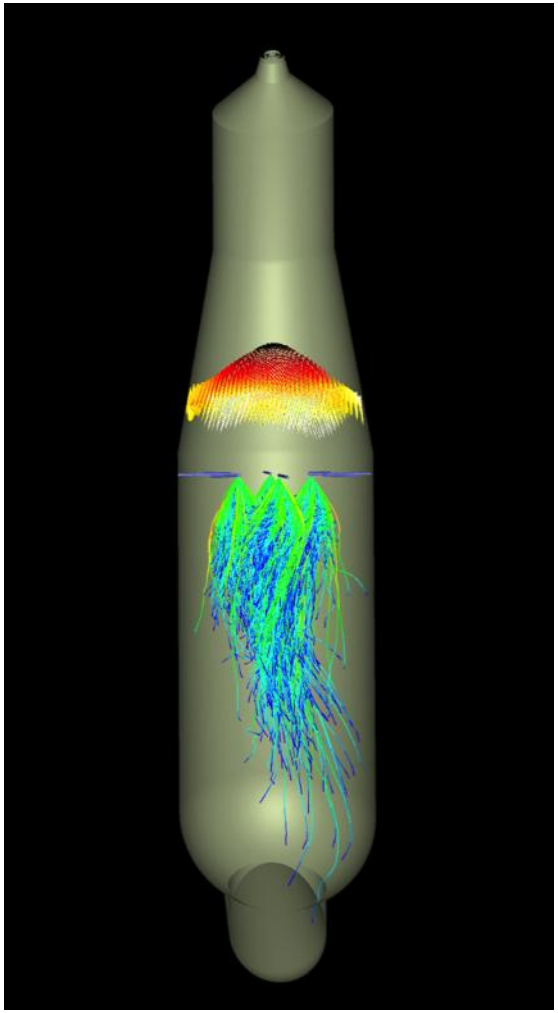
Urea price is stable and competitive with NH3



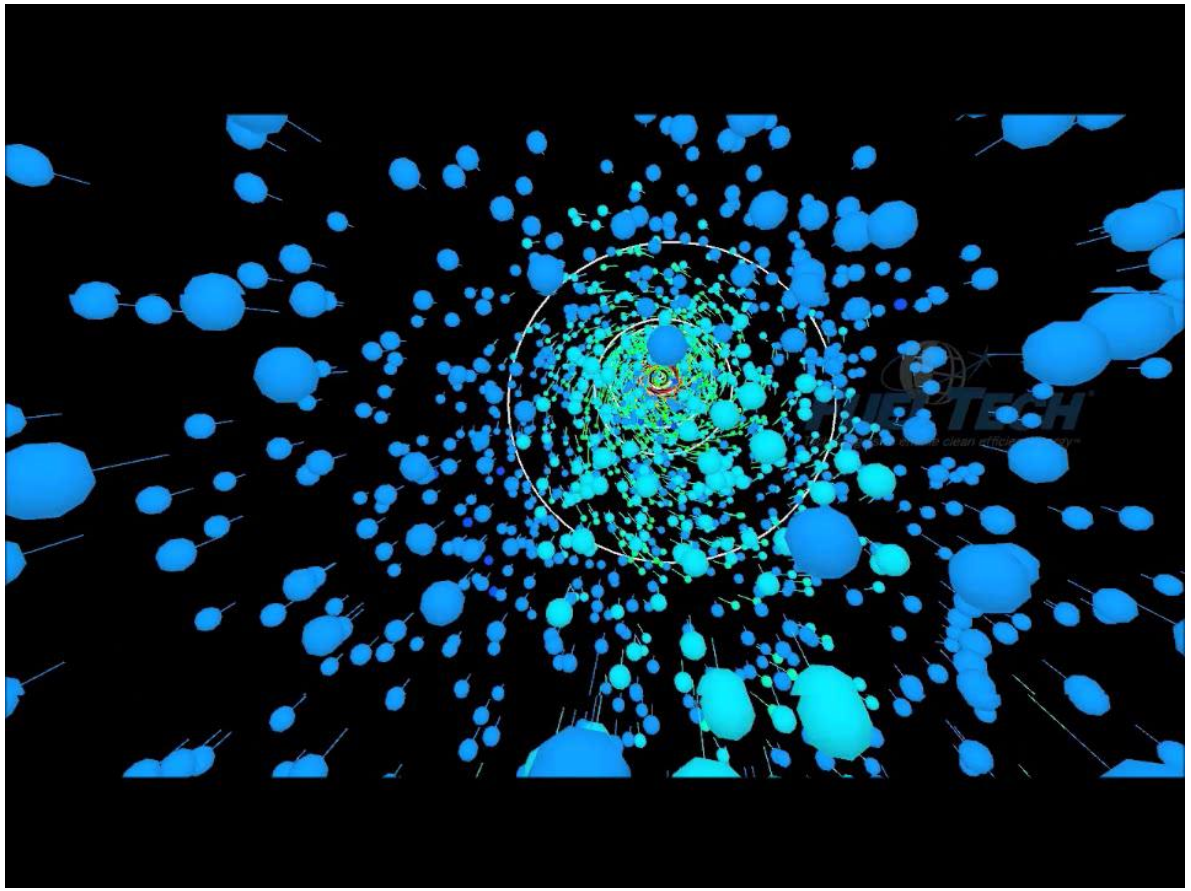
Readymade Solution, or On-Site Solution from Dry Pellets



THERMAL DECOMPOSITION OF UREA



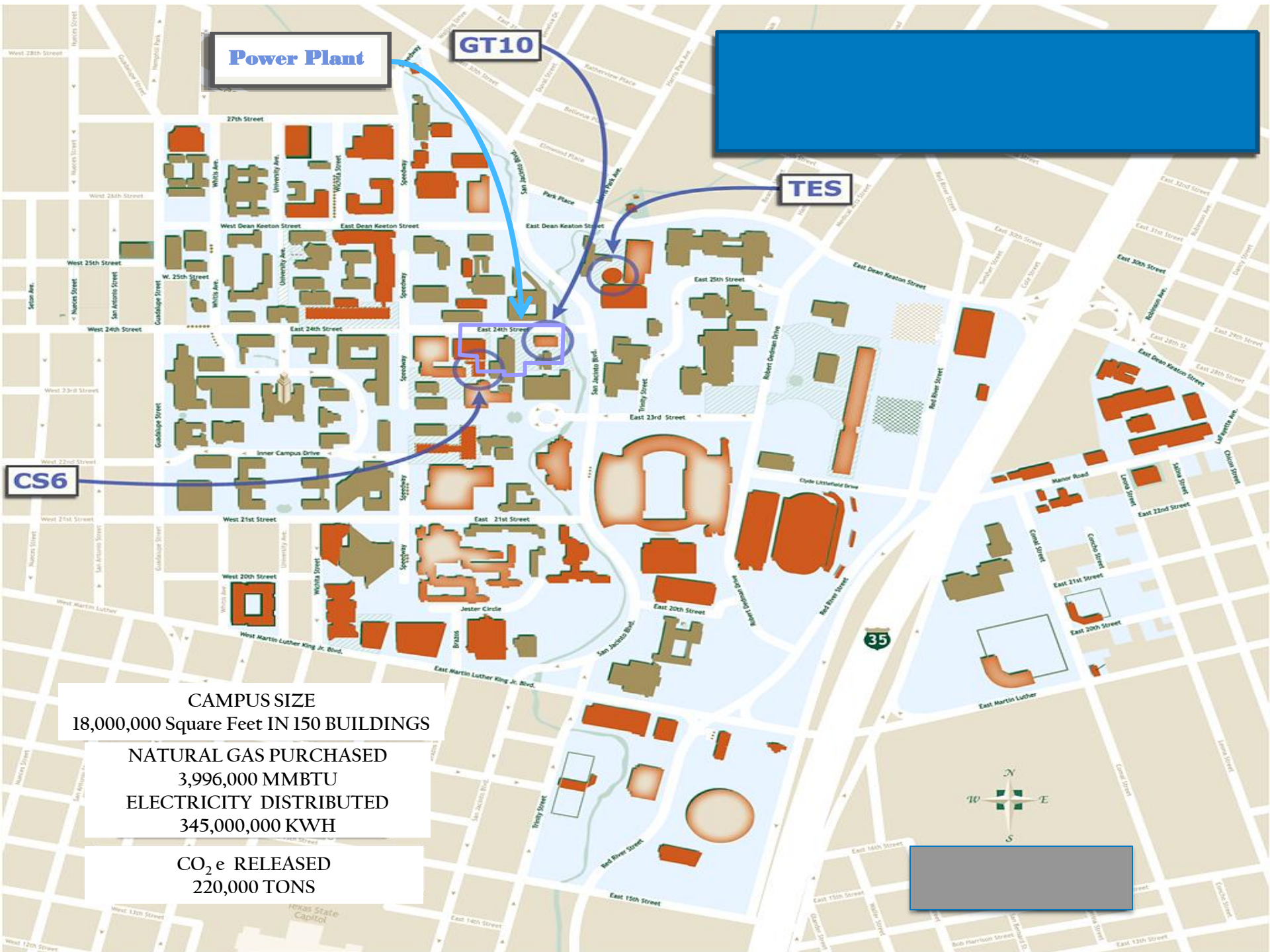
Computational Fluid Dynamics (CFD) and Chemical Kinetics Modeling (CKM) are used to determine reactor chamber design



CASE STUDY: 32 MW GE LB2500 W/HRSG

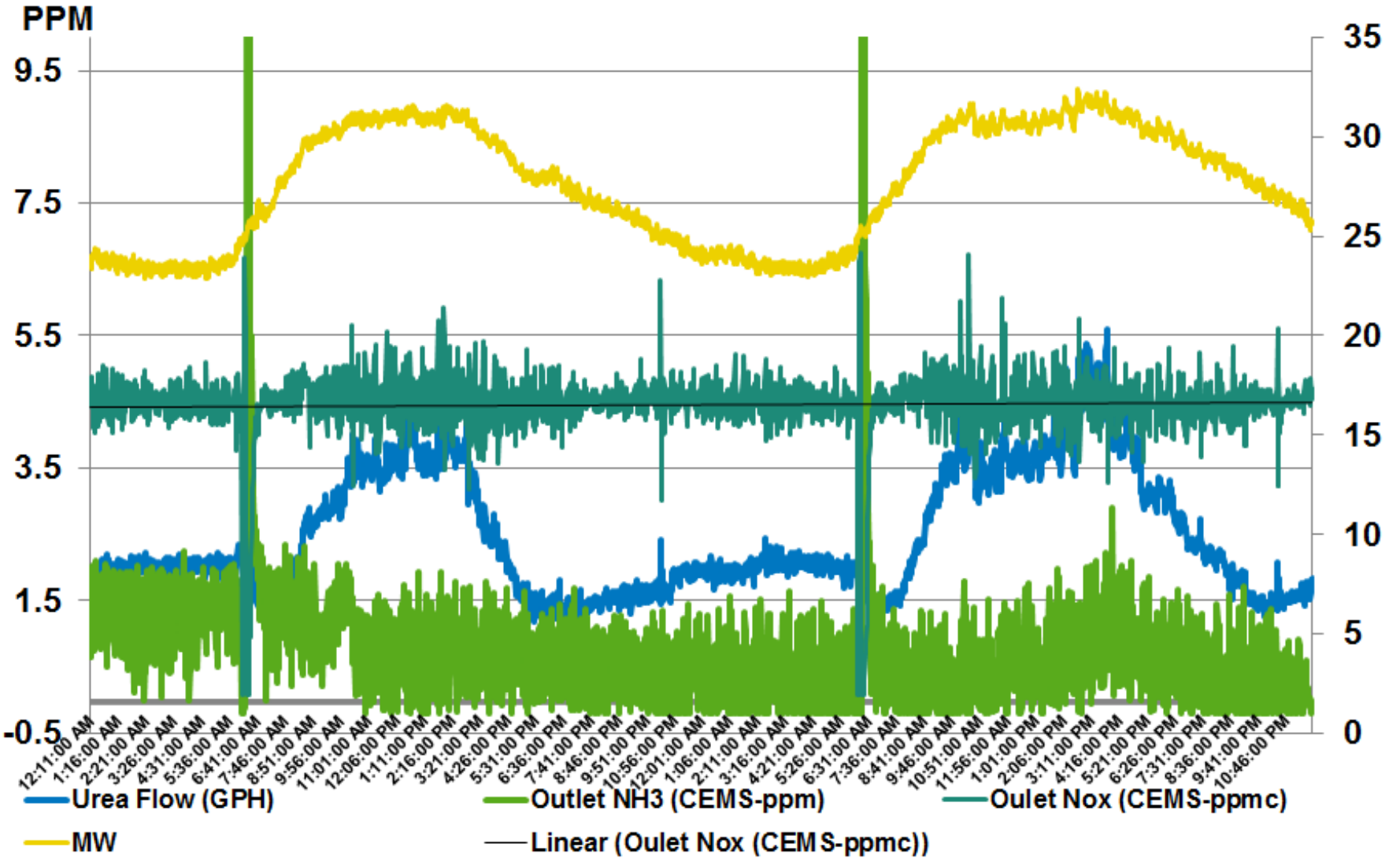
CASE STUDY: SYSTEM SPECIFICATIONS

- 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


Power Plant
GT10
TES
CS6
CAMPUS SIZE
18,000,000 Square Feet IN 150 BUILDINGS
NATURAL GAS PURCHASED
3,996,000 MMBTU
ELECTRICITY DISTRIBUTED
345,000,000 KWH
CO_2 e RELEASED
220,000 TONS


LIQUID CHEMICAL FEED

ULTRA LOAD FOLLOWING PERFORMANCE



CASE STUDY

For more information on this case study, please see our upcoming joint paper and presentation at the 26th Annual Campus Energy Conference

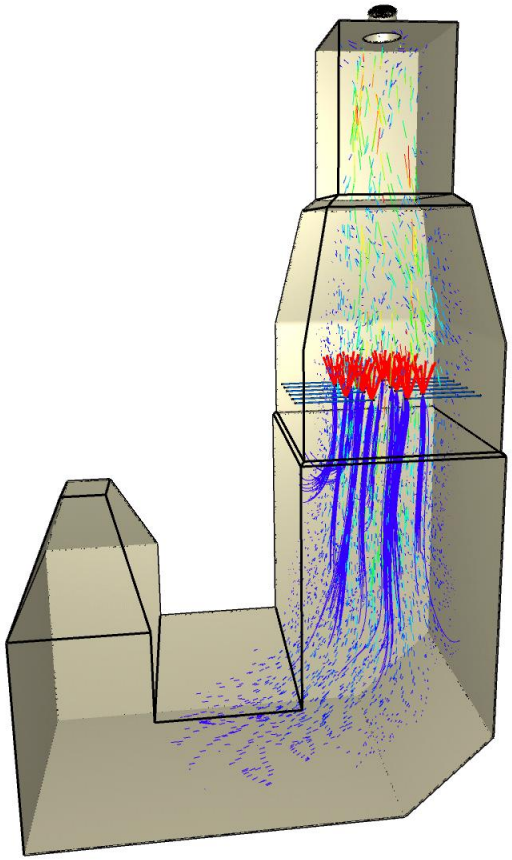
- http://www.cvent.com/events/idea-s-26th-annual-campus-energy-conference/event-summary-

UT Austin Efficiency Improvements & ULTRA System
Juan Ontiveros, University of Texas, Austin
Kevin Dougherty, Fuel Tech

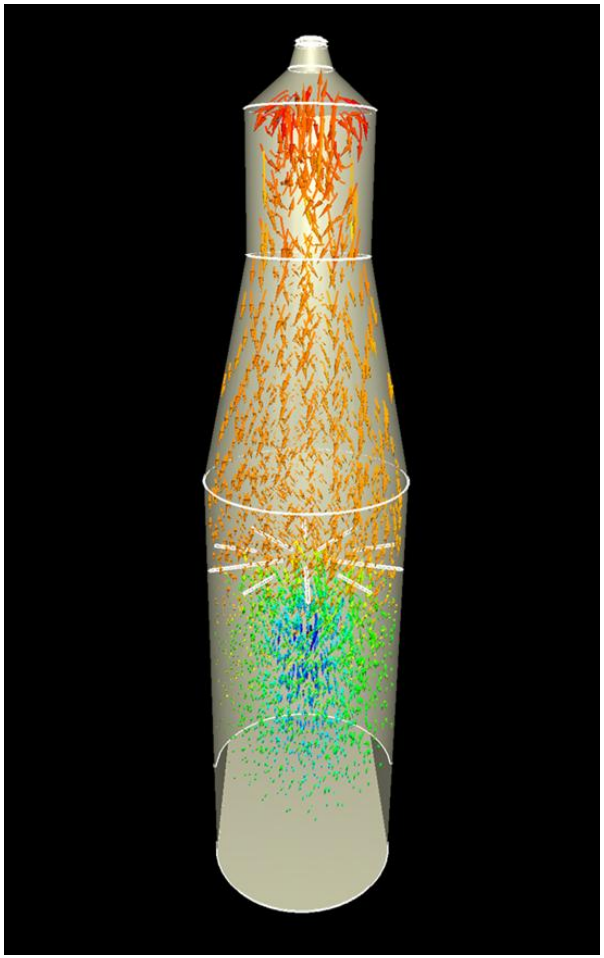
ULTRA: EXPERIENCE LIST (ABBREV.)

INDUSTRY	PRODUCT TYPE	COUNTRY	OWNER	UNIT/ LOCATION	# of UNITS	UNIT TYPE	Boiler Size	UNITS	FUEL TYPE (PRIMARY)	REAGENT RATE	UNITS	ULTRA FUEL	ULTRA AIR SOURCE	STARTUP DATE
Utility	ULTRA™	China	Datang Group	Taiyuan 2nd Power Plant, Taiyuan, Shanxi	2	T-Fired	300	MW	Coal	145	SCR Reagent kg/hr	Electric	Primary	2012
Utility	ULTRA™	China	Huaneng Group	Tongchuan Power Plant Unit 1& 2, Shaanxi	2	CFB	600	MW	Coal	150	SCR Reagent kg/hr	Electric	Primary	2012
Utility	ULTRA™	China	Shenzhen Energy	Mawan Power Plant Shenzhen, Guangdong	2	T-Fired	300	MW	Coal	125	SCR Reagent kg/hr	Electric	Primary	2012
Utility	ULTRA™	China	Datong Coal Group	Tashan Power Plant Datong, Shanxi	2	T-Fired	600	MW	Coal	280	SCR Reagent kg/hr	Electric	Primary	2012
Utility	ULTRA™	USA	Northern Indiana Public Service	Schahfer Station 14	1	Cyclone	520	MW	Coal	1200	SCR Reagent lb/hr	Gas	Ambient	2004
IPP/Co-Gen	ULTRA™ (D)	USA	Combustion Turbine	West Coast Location	1	HRSG	100	MW	Gas - Natural	100	SCR Reagent lb/hr	Gas	Ambient	2003
Utility	ULTRA™	USA	Northern Indiana Public Service	Michigan City Station #12 Michigan City, IN	1	Cyclone	520	MW	Coal	1200	SCR Reagent lb/hr	Gas	Ambient	2003
IPP/Co-Gen	ULTRA™	USA	MATEP	Peerless Manufacturing MATEP - Boston, MA	1	HRSG	15	MW	Gas - Natural	15	SCR Reagent lb/hr	Electric	Ambient	2002

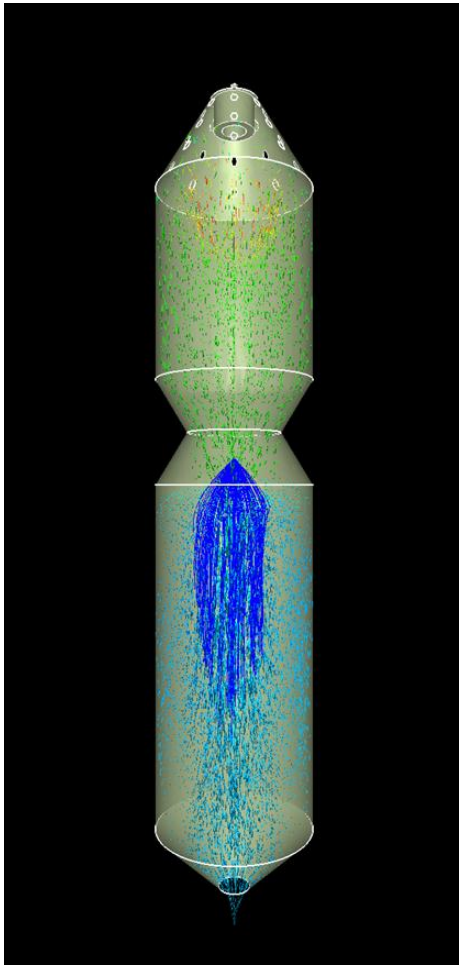
NIPSCO Bailly 8
1250 lb/hr

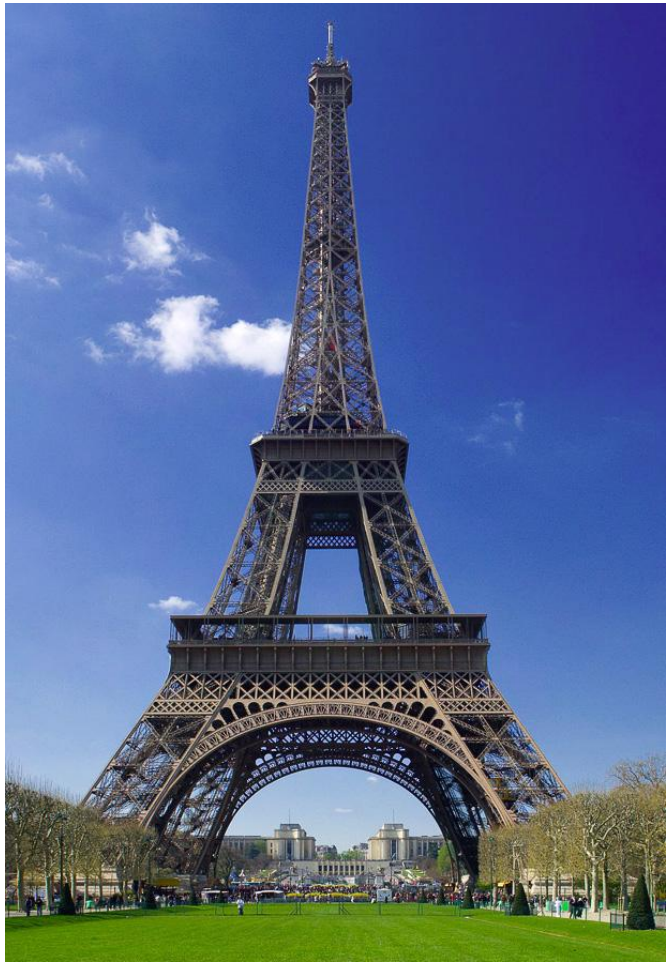


NIPSCO Bailly 7
720 lb/hr NH3



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