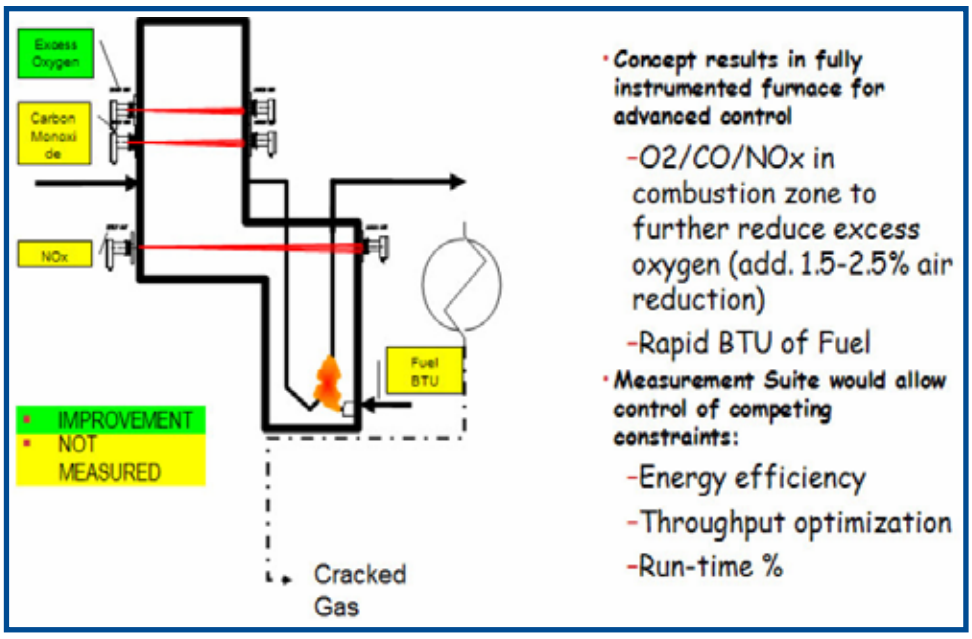
Advanced Diagnostics and Control for Furnaces, Fired Heaters and Boilers

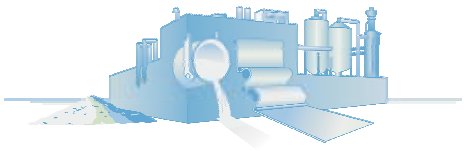
Improving Ethylene Furnace Operations Through Reliable and Fast Measurements

Pyrolysis of feed stocks (such as naptha, crack gas, etc.) into basic chemicals (e.g., ethylene, vinyl chloride monomer, etc.) is an important process for petrochemical industry. This process consumes enormous amounts of energy and represents an opportunity for the industry to lower its energy consumption. One of the prevalent unit operations associated with these industries is the furnace, where the combustion of fuel is used to generate large amounts of heat/radiation required to convert feedstocks into desired products. The models used to optimize ethylene furnace operations require measurements of constraints such as oxygen, CO, and NO_X. Currently, unreliable and inaccurate measurement data are used as model inputs which results in poor and inefficient control of the furnace.

Researchers will optimize ethylene furnace operations using advanced combustion diagnostics and rapid Btu measurements of fuel. These concepts will provide richer information to process optimization models currently in place. This approach will allow the industry to use existing models and to leverage current expertise and computational fluid dynamic (CFD) modeling capabilities to model heat transfer. Enhanced, spatially resolved hot zone measurements will help optimize and tune burners, achieve more uniform heat transfer, and minimize undesirable combustion by-products.



Fig, 1 Process schematic for optimizing a furnace using Advanced Combustion Diagnostics and Rapid Fuel Btu measurements. These concepts will provide richer information to process optimization models currently in place.



Benefits for Our Industry and Our Nation

Advanced diagnostics and rapid fuel measurements will help optimize furnace operations for the pyrolysis of feedstocks into basic chemicals. Technology targets include: CO sensitivity <2ppm; measurement of NO with sensitivity <20ppm; price and estimated installation costs of <$50,000 for older/smaller ethylene furnaces up to $100,000 for newer/larger furnaces. By 2020 energy savings in the chemicals industry could be as high as 85 trillion Btu

Applications in Our Nation's Industry

This effort will focus on furnace energy optimization; initially applied to olefins pyrolysis furnaces. In addition to ethylene and vinyl chloride monomer (VCM) furnaces, this technology will also apply to combustion systems in non-chemical processes such as refinery process heaters, metal and glass furnaces.

Project Description

The objective of this project is to develop and implement technologies that address advanced combustion diagnostics and rapid Btu measurements of fuels. These are the fundamental weaknesses associated with the combustion processes of a furnace.

Barriers

The ability to integrate these new measurements into a process control strategy is straightforward once the manipulated variables have been identified and implemented. However, the ideal goal of being able to tune individual burners, for example, will require significant improvements in burner design (adaptive burners) and will also require significant capital expenditure- comparable to typical installation costs encountered when installing low-NO_X burners.

Pathways

Tunable diode laser (TDL) technology will be implemented to obtain measurements of combustion gases in or near the combustion zone, and allow the formation of a measurement grid to optimize important furnace control variables such as excess air and tube metal temperature.

Rapid Btu measurement of fuels will allow for feedforward control of fuel and reduce coil outlet temperature variability. This will help more efficiently distribute fuel to furnaces.

The final objective is to integrate advanced combustion and fuel measurements into a process control strategy for furnace optimization.

In addition, the proposed system will be designed, tested, and evaluated in the field by experts familiar with the operation of a cracking furnace.

Progress and Milestones

This project started in September 2006.

- CO, NO and O_2 measurements at furnace output and burner zone
- Correlation of analytical measurements to process control
- Integrated Analyte profile measurement development and burner zone testing
- Fuel feed analysis development and testing
- Process optimization

Commercialization

Depending on final product configuration, commercialization could take place in the following forms:

- Direct analytical system sales with customer providing control system integration
- OEM sales to combustion systems suppliers. Combustion system supplier could provide turn-key solution including system optimization and periodic system tuning to correct for burner ageing.
- OEM sales to control systems suppliers. Control system supplier would provide turn-key solution similar to combustion system supplier.

Dow and ASI have already had preliminary discussions with combustion systems suppliers to validate those possible models. Dow and ASI have also had preliminary discussions with other large chemical producers to discuss the commercialization model.

Project Partners

Dow Chemical Company
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Analytical Specialties, Inc. (ASI)
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A Strong Energy Portfolio for a Strong America

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