



OpreX™ Asset Operations and Optimization

Fired Asset Safety, Control, and Optimization

CombustionONE



Today's Fired Asset Landscape

Operators of fired assets face a myriad of challenges including new recommended best practices, standards, and regulations. Meanwhile, all plant operators perpetually strive to raise the bar with safety improvements, emission reductions, optimization of fuel efficiency and production, lifespan optimization for assets and, if applicable, catalysts. Yet the overwhelming majority of combustion controls and burner management systems are designed and operated the same way they were 30 years ago.

CombustionONE

Single source solution for operational excellence in fired assets

CombustionONE is a comprehensive approach to fired asset management that includes hardware, software, and turnkey project services. CombustionONE has been proven to improve safety, increase fuel efficiency, increase productivity, minimize trips, decrease fouling and coking, reduce NO_x and CO₂ emissions, reduce SCR ammonia injection, and increase asset and catalyst life spans. The CombustionONE suite applies to heaters, furnaces, steam methane reformers, crackers, and boilers--essentially any asset with a flame.



According to the EIA, industrial process heating operations are responsible for more than any other of the manufacturing sector's energy demand, accounting for approximately 70% of manufacturing sector process energy end use.



EIA: Fired heaters are collectively the largest energy consumer in all of the manufacturing sector and represent a tremendous opportunity for energy savings, production increases, or a combination of both.



Most fired heaters do not meet the new industry recommended best practices such as API 556.



If accurate and frequent measurements of CH₄, O₂, and CO concentrations are not available, operators tend to allow surplus excess air in the heater because they are concerned about safety. However, this reduces thermal efficiency and production capability, while negatively impacting emissions and asset/catalyst lifespan.



Plants not meeting the new industry guidelines are at risk in the event of an incident in a fired asset.

During day-to-day operations, fired asset operators face an array of problems throughout the combustion process:

Pre-combustion

Most fired assets lack a real-time measurement of the fuel heating value. If the fuel consists of blended components, the heating value can rapidly change and cause problems such as wide swings in the coil outlet temperature and O₂ content in flue gas. Such swings need perpetual attention. They raise levels of fouling and coking and as a result can cause trips.

Combustion

Most fired assets using air/fuel ratio control loops are biased by a manual or automatic O₂ trim loop. The O₂ trim setpoint balances safety with efficiency. Safety always takes precedence; a surplus of excess air ensures consumption of all combustibles. Typically, the excess air is kept at an unnecessarily high level that results in excessive fuel consumed, excessive CO₂ and NO_x emissions, and reduced production efficiency.

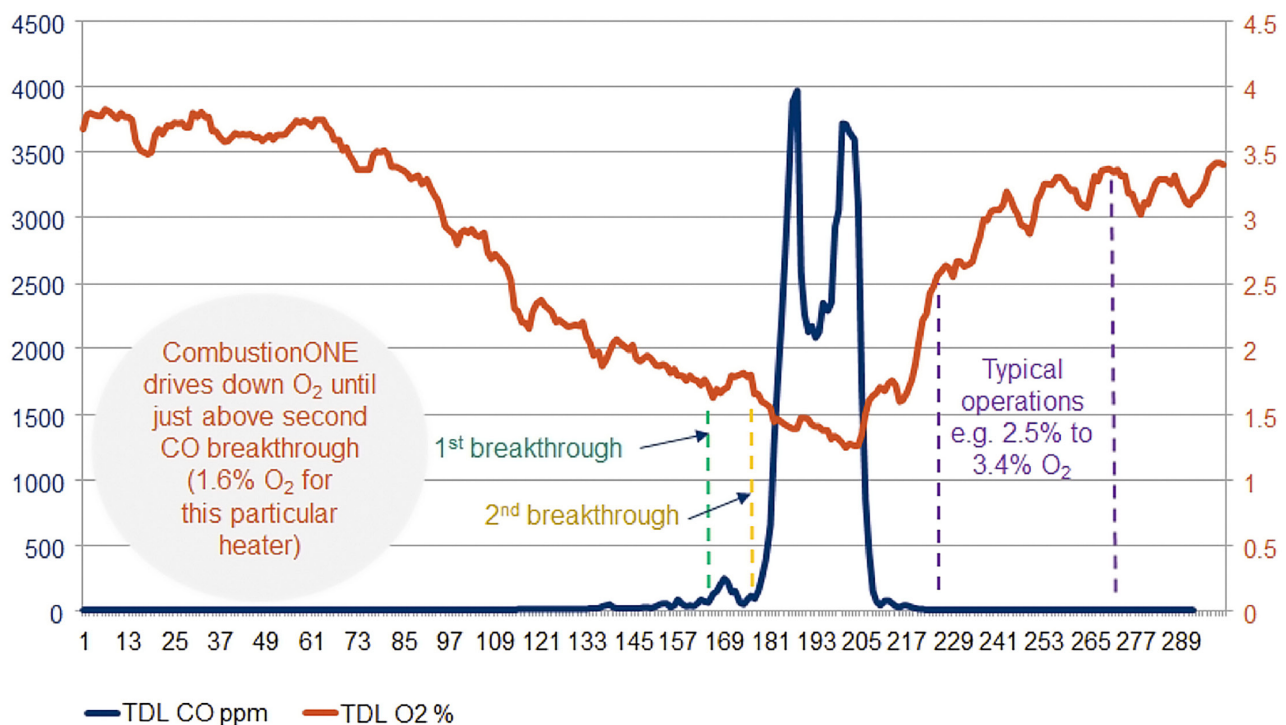
The optimal O₂ level can be determined only if the CO breakthrough point is known. With an air/fuel mixture that is biased by cross limited O₂ and CO trim, the breakthrough

is when O₂ is reduced to a point where CO spikes. This breakthrough point is unique for every fired asset and depends on burners, fuel composition, and furnace pressure.

Post-combustion

Industry groups such as API 556 have recognized that the traditional approach to O₂ content measurement in combustion gases using zirconium oxide probes presents a safety hazard because they operate above the CH₄ ignition temperature. Since they cannot be located in high temperature radiant sections, they do not provide proper measurements in non-homogenous combustion gases. When placed after the convection section or in the stack, they often add long measurement delays that could be arbitrarily skewed by tramp air. Not only does the zirconium oxide technology present a potential safety risk, it contributes to excessive fuel consumption, excessive emissions, and decreased production.

Additionally, most fired heaters do not meet new industry standards such as NFPA 87 with existing instrumentation and manual control of the air supply. Plants not meeting new industry guidance are at risk in the event of an incident in their fired assets.

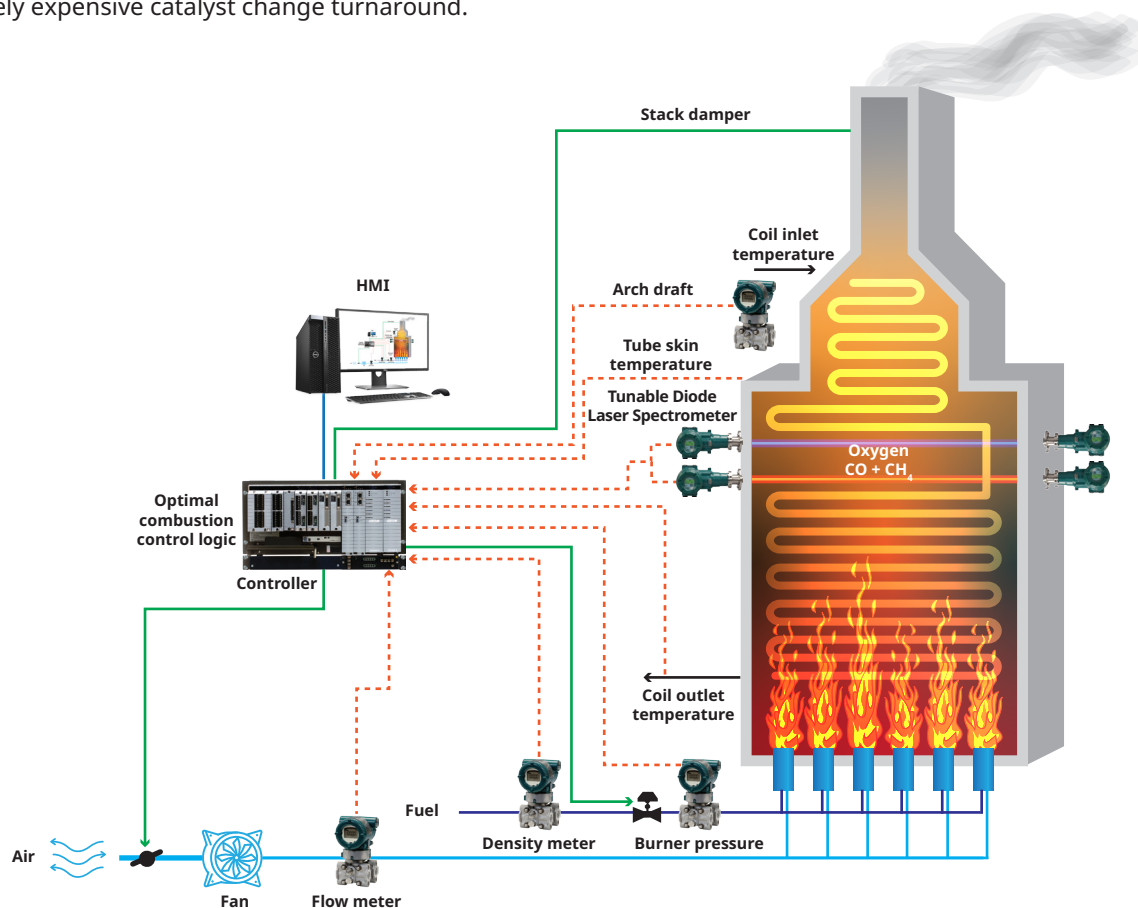


By determining the CO breakthrough point, CombustionONE can improve fuel efficiency, increase production capacity, reduce emissions, and increase fired asset lifespan. This chart shows an oil burning heater safely operating at 1.6% O₂. As noted in API 556, safe combustion of gas at 1% O₂ or lower is possible.

Fired Asset Opportunities

CombustionONE transforms fired asset problems into opportunities by targeting the following:

- Fast and accurate measurements of O_2 , CO , and CH_4 improve safety. Zirconium oxide probes can cause explosions and provide dangerously inaccurate O_2 readings; in contrast, a TDLS installed in the radiant section provides near real-time O_2 and CO measurements that are not skewed by tramp air. The CH_4 measurement can also provide a light off permissive, confirming a successful purge.
- Accurate measurements provide fuel savings and increased process throughput. Rather than biasing the air/fuel ratio with an arbitrary O_2 setpoint based on an error-prone O_2 reading, the rapid air/fuel ratio measurement and control loop in CombustionONE allows the fired asset to safely operate much closer to the CO breakthrough point.
- Substantially fewer trips and increased asset life result from stabilized coil outlet temperature and O_2 content in flue gas. For fired assets such as steam methane reformers, which utilize catalyst in the tubes, avoiding trips can be critical to extending the life of the catalyst and delaying an extremely expensive catalyst change turnaround.
- A real-time heating value estimate enables continuous bias of the air/fuel ratio to stabilize combustion and heat transfer into the tubes. This significantly eases fired asset operation while minimizing the thermal stresses on the tubes, even under conditions such as wide swings in demand or fuel heat value.
- Well balanced burners reduce maintenance costs and allow longer run times between turnarounds. Balancing the burners and stabilizing the coil outlet temperature equalize the load and reduce aging of all radiant section components.
- Reduced coking results in fuel savings and maintenance cost reductions. Stabilized combustion reduces tube deposits, which accelerate at high temperatures. By smoothing out temperature peaks, fired asset operators reduce the amount of decoking that is necessary and maintenance time required.
- Significant emissions reductions are attainable. Reduced NO_x emissions will decrease the load or even eliminate the need for an SCR, and the corresponding ammonia injections. Ultimately, reduced CO_2 emissions mean fewer carbon credits and a cleaner world.



CombustionONE Typical Solution

The CombustionONE Suite for Fired Asset Measurement, Control, and Optimization

CombustionONE is an integrated suite of hardware, software and services that meets the measurement, control and optimization needs of nearly any fired asset. CombustionONE encompasses the full scope of combustion control and burner management with fired asset design, operational methodologies analysis, rigorous simulation, and turnkey installation. Post-project support ensures sustainability of all improvements.



Safety is always the highest priority in combustion improvements. As a single source solution, CombustionONE offers increased efficiency, maximized throughput, and reduced emissions, all while increasing safety across the process.

All products and services in the CombustionONE suite have been designed to work with existing measurement and control systems.

The CombustionONE Suite

■ CombustionONE for Measurement

According to ARC Insights, energy is second only to raw materials as a leading cost affecting manufacturers. New analysis techniques such as Tunable Diode Laser Spectroscopy (TDLS) can improve efficiency, maximize throughput, reduce emissions, improve safety, and reduce energy in combustion processes. CombustionONE focuses on comprehensive measurement instrumentation and analytics, with particular emphasis on TDLS for fast and accurate post-combustion gas analysis.



CombustionONE uses precise readings from instruments such as Yokogawa's DPHarp flow transmitter (left) and the TDLS 8000 analyzer for measurement of O₂, C_o, CH₄, and NH₃ concentrations.

CombustionONE measurements include:

- Instrumentation for burner balancing, fuel density, fuel flow and stack flow
- Wind compensation ring for stabilized stack flow measurements
- O₂, CO, CH₄, NH₃ TDLS 8000 analyzer
- Continuous Emissions Monitoring System (CEMS)
- Engineering and Installation services

■ CombustionONE for Control

CombustionONE can work in conjunction with existing combustion controls and burner management applications or replace outdated equipment as needed. CombustionONE provides complete automation and safety system consulting and engineering services.

CombustionONE control capabilities include:

- Advanced combustion controls
- Improved burner management
- Updated graphics and historian
- Performance reports
- Engineering services



CombustionONE employs DCS, PLC, Safety Instrumented System (SIS) or supervisory controls, whichever are most appropriate.

The CombustionONE measurement and control capabilities, when used together, enable producers to meet or exceed the recommended industry best practices for safe and efficient operation of fired assets.

■ CombustionONE for Optimization

CombustionONE offers complementary optimization capabilities that transform plant performance from good to great and from great to repeatable:

- Feedwater pH optimization
- Ammonia slip optimization
- Combustion optics
- Turbomachinery controls
- Plant master and energy optimization
- Startup/shutdown procedural automation to simplify operations
- Digital twins and full plant performance improvement analytics
- Operator training simulators
- Remote diagnostics via secure cloud
- Full plant performance improvement analytics, before and after implementation



CombustionONE employs advanced analytics and asset modeling in order to enable a higher level of fired asset optimization.



According to the EIA, the largest risk in fired heater operation is during startup and shutdown sequencing.

Yokogawa Managed Solution Simplifies Implementation

The installation of CombustionONE on a fired asset is simple. As the Main Automation Contractor (MAC), Yokogawa manages the implementation and installation of the entire automation solution, including third party products and services. Yokogawa is the single point of responsibility for all aspects of the project, including modifications and refurbishment of the fired asset.

The turnkey solution provides the following benefits:

- A single source provider of automation, heater hardware, and mechanical services
- Design reflecting the end user requirements and standards
- Maximum project ROI; greatest value at lowest cost
- Shorter project schedules with minimum process downtime
- Lifecycle support for all aspects of CombustionONE
- Reduced total cost of ownership

“CombustionONE is the only integrated solution that provides increased safety margins and greater thermal efficiencies, while reducing emissions. This means greater life and lower maintenance costs for our fired heaters.”

— A Major Gulf Coast Refining Company

Throughout our hundreds of CombustionONE installations globally, Yokogawa's team has provided engineered solutions that work across a broad range of conditions, including extreme climates. When physical and process changes to the fired asset are required, Yokogawa partners with leading engineering companies and furnace manufacturers to provide a holistic solution that leverages existing automation whenever possible.

Proven CombustionONE Methodology

To offer an integrated lifecycle solution for upgrading and sustaining the fired asset, Yokogawa has partnered with leading suppliers of industrial fired heater equipment. The CombustionONE methodology uses a proven process:

- **Qualify:** Simple operational data to quickly determine if CombustionONE is feasible
- **Understand:** Conduct a site survey and confirm the customer's goals
- **Analyze:** Review site information and generate a findings report
- **Design:** Provide turn-key design that increases safety and efficiency
- **Implement:** Execute the project through start-up and training
- **Sustain:** Maintain fired heating asset performance through continuous support

Continuous Lifecycle Support

The Yokogawa continuous support program ensures that fired assets meet the latest best practices, while improving performance and extending the life of the asset. These services include:

- Periodic inspections
- Evaluation of operation efficiency and identification of gaps
- Engineering design and fabrication
- Asset repair and improvements
- CombustionONE system updates
- Remote diagnostics of asset performance
- Remote and on-site support

The Yokogawa CombustionONE solution allows operators to meet new industry standards, improve efficiency and safety, optimize all fired assets, and enhance sustainability through effective lifecycle management.



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