SPARTAN CONTROLS

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Spartan Combustion Management

Solutions for Industrial Fired Equipment

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Industrial Water Tube Boilers

100MMBTU/H WATERTUBE BOILER

CHALLENGE

Our customer expressed the need to address the NOx emissions associated with the existing burner and to modernize the Burner Management System, which was approaching obsolescence. Upon initial review, several challenges were identified within the existing system:

- The original equipment manufacturer (OEM) design, implemented during the initial installation, did not align with the client's specifications and lacked compliance with IEC61511 standards
- Limited space for integrating new instrumentation
- Challenges with airflow measurement and control caused by unreliable airflow and outdated damper drive
- Limited visibility of BMS on the Distributed Control System (DCS) due to Modbus mapping and IO interfacing

SOLUTION

Spartan offered a comprehensive solution by providing a complete new combustion package, incorporating a full IEC61511 design. The package consisted of the following components:

- New Low NOx Burner with staged combustion
- High Energy Spark Ignition (HESI) technology to eliminate the need for a separate pilot train
- A pre-assembled Fuel Train with Coriolis Mass Flow meters, optimized for limited straight runs
- Burner Venturi utilized for airflow signal and new vane-style damper actuators for improved airflow control
- Integration of DeltaV SIS Hardware for seamless integration with the Plant's DeltaV DCS, eliminating the need for Modbus mapping and I/O interfacing

VALUE

- Improved Safety and Reliability
- Over 50% NOx reductioin
- Reduction of Oxygen throughout firing curve

Fired Heater

50MMBTU/H STEAM SUPERHEATER

CHALLENGE

This is a high-capacity (4) burner 50MMbu/h fired heater. The client sought to ensure full compliance with the MSAPR regulations for NOx emissions.

The primary challenge stemmed from the existing heater's utilization of a mixed fuel combination of natural gas and purge gas, which had varying BTU input. The absence of airflow measurement and the shared stack with other equipment complicated draft and O_2 control. To ensure safe operation, the team maintained higher air levels in the heater, accepting a modest trade-off in efficience.

VALUE

- Improved O_2 and draft control for both safe and efficient combustion firing
- Reduced project risk and lower installation and commissioning timeline due to packaged assemblies
- Final startup and commissioning to ensure full front-to-back support
- Greater than 20% reduction in NOx
- Improved efficiency with the addition of draft control

SOLUTION

To achieve the objective of NOx compliance and enhanced control of the furnace air-fuel ratio, the following comprehensive solution was implemented:

- New Low NOx Burners, Flame Scanners, and Retractable Ignition System
- New custom designed Air Flow Element in the inlet Ducting
- New blower, custom damper and VFD for operational efficiency
- Fuel Train designed for multi-fuel (Nat Gas and Purge Gas)
- BMS Control Panel (DeltaV SIS)
- Custom design, fabrication and packaging to minimize on-site field installation
- Custom Windbox and ducting
- Multi-burner Fuel train fully pre-assembled and pre-wired
- E-house to house VFD (s) and BMS Control Panel
- Integrated Function Acceptence Testing (iFAT) in-shop to minimize onsite C&SU effort
- Commissioning and Startup
- CSA Field Approval

Fired Heater

LOADOUT HEATER

CHALLENGE

The loadout heater was of original vintage, and over time, both the coil and furnace conditions had deteriorated. Additionally, the controls and instrumentation were also original vintage, with several components nearing obsolescence.

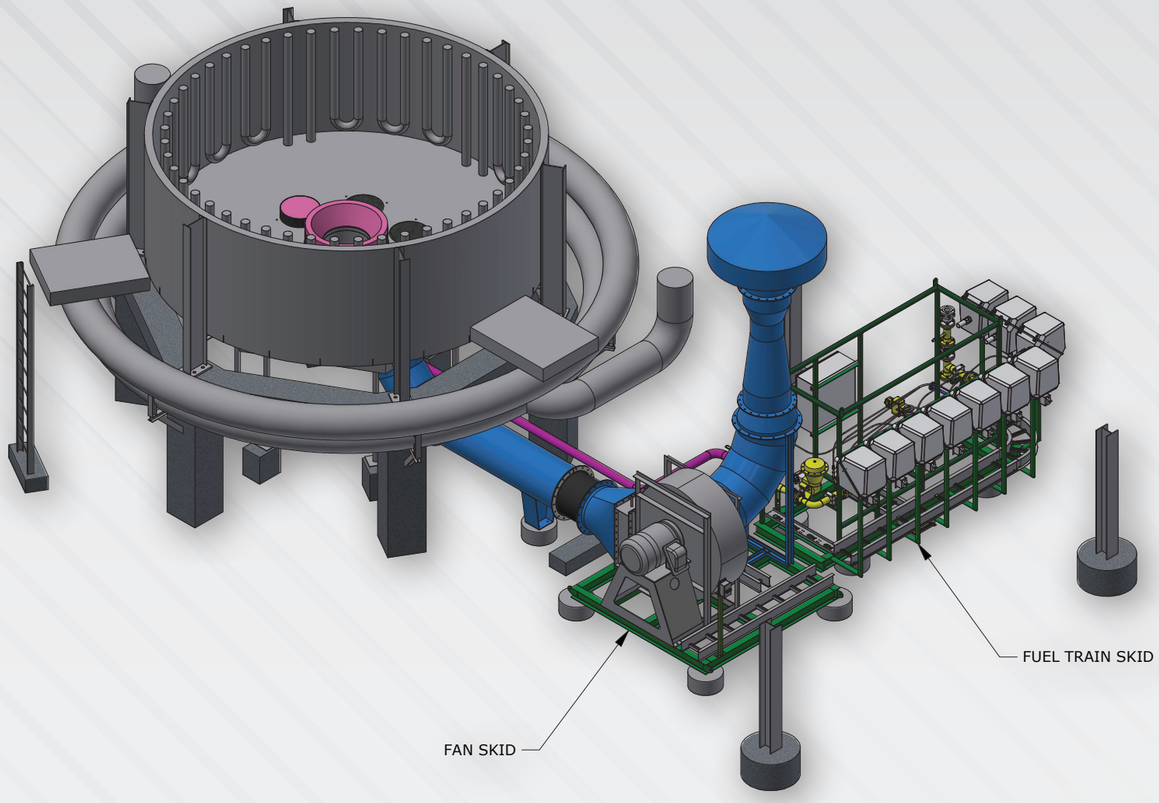
SOLUTION

Spartan conducted a thorough cost/benefit evaluation to compare retrofitting existing heater components with the option of a new Heater Skid. After careful consideration, it was determined that a complete heater replacement would offer a more cost-effective solution, along with numerous long-term benefits. The following components were supplied by Spartan:

- Replacement Heater including new furnace, ammonia coil, stack, and recirculation blower – design customized to utilize existing piles/piers to reduce civil work
- Add-burner equipment - (2) Low NOx Burners (30ppm) with direct spark ignition and redundant scanners
- Combustion air – New Blower with Inlet Suction Venturi for airflow, with damper and VFD for control
- Fully assembled fuel train skid design for dual-burner application
- DeltaV SIS Hardware used for BMS resulting in seamless integration with Plant's DeltaV DCS, eliminating Modbus mapping and IO interfacing
- Engineering and Project Management (IEC61511 design)
- Startup and Commissioning and CSA Field Approval

VALUE

- Full turnkey package, minimizing on-site installation and commissioning
- Successful implementation and coordination - the project covered a multitude of engineering disciplines and stakeholders
- Less than 30 ppm NOx emissions



Fired Heater

STARTUP HEATER

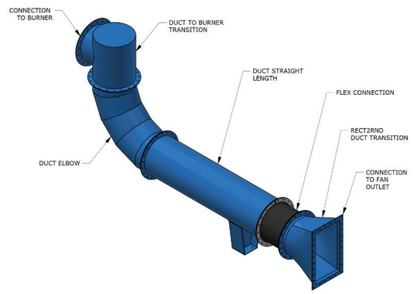
CHALLENGE

The existing heater poses a challenge as a seven-burner natural draft vertical cylindrical heater, where the key objective is to reduce NOx emissions and modernize the system for improved reliability.

SOLUTION

The natural draft burners inherently lack efficiency in design. Instead of simply replacing the existing burners with seven new natural draft Low NOx burners, Spartan has taken a unique and innovative approach. Our plan is to convert this heater into a single burner Low NOx Forced Draft Burner system, thinking outside the box. This solution not only addresses the NOx and reliability objectives, but also brings the added benefit of significantly improving the unit's thermal efficiency and reducing greenhouse gas (GHG) emissions.

- Low NOx Forced Draft Burner - direct spark and (3) scanners for improved uptime
  - Cutout refractory floor, replacing it with a pre-fabricated floor section that includes burner mounting and refractory
- Blower with Inlet Venturi and VFD for better air-fuel ratio control and operational efficiency
- New fuel train skid, fully pre-assembled and pre-wired to the BMS Panel
- New DeltaV SIS BMS Panel
- Engineering work-package ensuring compliance with IEC61511 standards

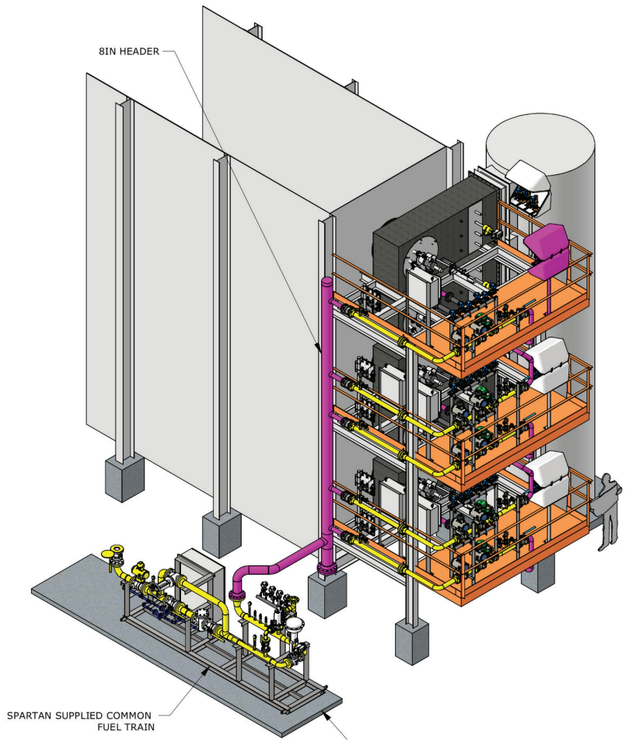


VALUE

- New FD design providing higher turndown, reliability, improved efficiency, and lower NOx and GHG emissions
- Improved safety, reliability, and uptime of the system
- Reduction in complexity by consolidating from seven burners to one

Aux Boilers (Multi–Burner)

300MMBTU/H STEAM AUXILIARY BOILER



CHALLENGE

This is a five burner boiler that utilizes pre-heated fuel gas at 260C. Each burner requires independent firing rate control. However, due to limited instrumentation on the existing system, this results in a significant amount of manual operator intervention needed to effectively run the boiler.

In addition, both the fuel and air systems present their own complications. The fuel gas used is pre-heated at 260°C, which means specialized components rated for high-temperature service are required. Additionally, there is very limited static pressure available, making burner selection and airflow control challenging.

The objective of this project is to modernize the system to meet CSA B149.3 compliance while also addressing the above operational challenges.

Aux Boilers (Multi–Burner)

SOLUTION

Spartan performed an upfront FEED study to better assess the operational challenges, resulting in the following solutions: supplied a complete pre-assembled and pre-wired fuel train skid connected to a Burner Management System (BMS) panel, and installed a new Low NOx burner with staged combustion.

- Custom windobox assemblies with air-flow measurement and custom damper control
  - An airflow study was conducted to develop an airflow element that utilizes minimal static DP. This involved in-house CFD and a physical 1-to-1 scale test mock-up built to test the expected airflow profile and determine the flow element design and installation location to meet the objective
  - Custom averaging pitot tube design with two out of three voting for higher uptime
  - Custom designed opposing blade dampers using actuators and DVC with 4-20mA feedback
  - Added common header Pressure Control and furnace draft pressure for improved and stable air-flow control
- Fully pre-assembled fuel train designed for multi-burner application – (1) common fuel train skid and (5) individual burner train assemblies
- Direct Spark Ignition on burners – eliminating pilot train
- Special build gas safety shutoff valves and flow measurement for high-temperature gas service
- Individual burner cross-limited air-fuel ratio control
- Define the control design parameters for the BMS and DCS vendors – BMS panel built and tested at Spartan shop
- Full IEC 61511 SIS design
- Skid fully pre-wired and factory shop-tested prior to shipment – reduced on-site installation and commissioning effort

VALUE

- Improved safety and reliability
- Less operator intervention with automated individual burner control
- Met tight turnaround window for installation and commissioning
- Increased efficiency due to air-fuel control

Primary Reformer

800MMBTU/H PRIMARY STEAM METHANE REFORMER

CHALLENGE

This is an 800MMBtu/h SMR with 160 bottom-fired burners, where the gas has a mixed composition. The fuel and combustion air are supplied by an upstream turbine exhaust. To accommodate our Customers new process demands, the original turbine needs to be replaced, which in turn requires changing all 160 existing burners. Additionally, there are differences in airflow volume and composition.

Given the large number of burners involved in a Reformer application, any modifications to the burner design must be thoroughly evaluated. Field changes would be expensive due to the high quantity of burners. It is crucial to monitor and control airflow and draft more effectively, considering the limited straight runs and static pressure available.

The reformer area experiences high ambient temperatures, posing a challenge for operations. Flame detection is also complicated by the presence of H_2 in the fuel, which masks the UV signal. Furthermore, limited support is available directly from burner vendors, and operators have limited familiarity with the equipment due to infrequent startups (turnaround every 3-4 years).

Typical CSA/NFPA gas code configurations are not practical or cost-effective for this project. Therefore, the project expects to require code variance declarations in order to meet its requirements. Any changes to burner design must be thoroughly evaluated since any field changes would be very costly due to large number of burners.

SOLUTION

Spartan assumed the role of a combustion expert for this project and worked collaboratively with the client to address many of the challenges associated with such a complex application.

- Burner Firing Tests - Conducted in-house to ensure proper ignition and flame detection despite limited support from the burner vendor
- Airflow Modelling - Used physical and CFD modelling to ensure reliability of the newly designed air-flow element signal
- On-site Test-Runs - Verified equipment's ability to withstand high ambient temperatures
- Flame Scanner Testing- Tested four scanners to validate the correct choice for accurate flame detection
- Utilization of Spartan's Patented Reformer Design - Implemented to supervise "as few" burners as possible, requiring code variance declaration
- Packaged Equipment - Minimized field turnaround scope by packaging equipment into small assemblies
- New E-House Building - Designed to accommodate the GT Panel and Triconex SIL- Rated BMS, following IEC 61511 standards

VALUE

- Reduced project risk and improved certainty through upfront testing and proper scoping
- Lowered Project Costs - Application knowledge resulted in a safe system with minimum instrumentation
- Shortened Installation Timeline - Achieved through packaged assemblies
- Final startup and Commissioning - Ensured full front-to-back support
- Improvement Light-Off Efficience - Enhanced system performance
- Improved Safety and Fuel-Air Control - Optimized combustion reliability

Dryers and Air Heaters

AIR-PREHEATER PACKAGE

CHALLENGE

The site had an initiative to increase the preheat on the process air of their Coarse Electrostatic Precipitator (ESP). Due to time-constraints, a turnkey approach was essential.

SOLUTION

Spartan delivered a complete turnkey air preheater skid package. The air preheater used fresh air intake to heat up the air entering into the ESP. Based on the process requirement, the design allowed the heated air and flue gases to be directed to the atmosphere or to the process via separate damper control. The package included the following:

- Duct Burner Assembly - Housed in a carbon steel painted furnace with a precase refractory lining
- Blower System - Four blowers with inlet and outlet ducting/silencers
- 316 SS tee with blow-off and process dampers – high temperature rated
- Fuel Train Assembly – B31.3 and B149.3 compliant
- Pre-Wired Equipment - Fully wired to a DeltaV SIS BMS cabinet, CSA certified prior to shipment
- Structural Steel Skid Frame – CWB welding package included
- Engineering, Commissioning, and Startup (C&SU)

VALUE

- Full turnkey package minimizing on-site installation and C&SU
- Reduction of moisture in the air system

Sulphur Furnace

Burner Management System Modernization

CHALLENGE

The purpose of natural gas warm-up burners in a sulfur boiler is to raise the temperature for operators to install molten sulfur guns during startup. Operators' familiarity with the equipment can be limiting due to its infrequent use. Gradual warm-up is essential for refractory integrity, making burner selection critical.

SOLUTION

As part of a BMS modernization project for a 50MMbtu/h sulfur boiler, Spartan provided a comprehensive combustion package to address the challenges. Our solution included:

- 50MMbtu/h NG Burner - Equipped with direct spark ignition, this burner operates across a wide air-fuel ratio for gentle furnace warm-up and optimal flame geometry
- Permanent Mounting - Installed on the furnace side, eliminating the need to switch warm-up burners with liquid sulfur guns for enhanced safety
- Direct Ignition - An automated assembly keeps the igniter out of the hot zone, improving reliability
- Fuel Train Skid - Pre-assembled, pre-wired, and shop-tested
- Air Damper and Actuator - Ensures precise air-fuel ratio control
- New BMS - Manages safe startup and shutdown

VALUE

- Improved Safety - Fixed-mount burner and automated ignition enhance safety for operations
- Improved Reliability - High-excess-air burner and high-energy ignition enhance system reliability
- Reduced Project Risk - A fully tested skid assembly and BMS minimize installation and commissioning time during startup

INTEGRATED FACTORY ACCEPTANCE TEST OF AUX BOILER PROJECT

The common fuel train and five individual burner fuel train were connected to the safety (BMS) panel, including a test DCS to ensure all communications and BMS logic were functioning as designed. The advantage of this over typical software FAT is that it allows us to test the system dynamically, including load testing of all I/O. Flame scanners, ignition systems are all proven using small representative pilot burners operating on natural gas. The iFAT provides an excellent opportunity for operator and maintenance training prior to TAR.

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