New Refinery Waste Heat Boiler

Babcock & Wilcox (B&W) designed a new waste heat boiler for a Midwest refinery. The scope included an engineering study and computational fluid dynamics (CFD) modeling, engineering, equipment supply and delivery. The customer's goal was to improve boiler operation and unit reliability and reduce maintenance.

B&W Scope

ASME Section VIII Unfired Waste Heat Boiler System Supply

- Modularized water-cooled membrane furnace panels with inlet and outlet headers
- Buckstays, steam drum supports including structural members, tie bars, pins, clips, plates
- Two generating bank modules
- One economizer bank module
- Superheater module
- One-drum design including steam drum internals and cyclone separators
- Downcomers, supplies and risers
- Diamond Power® IK-700® sootblowers

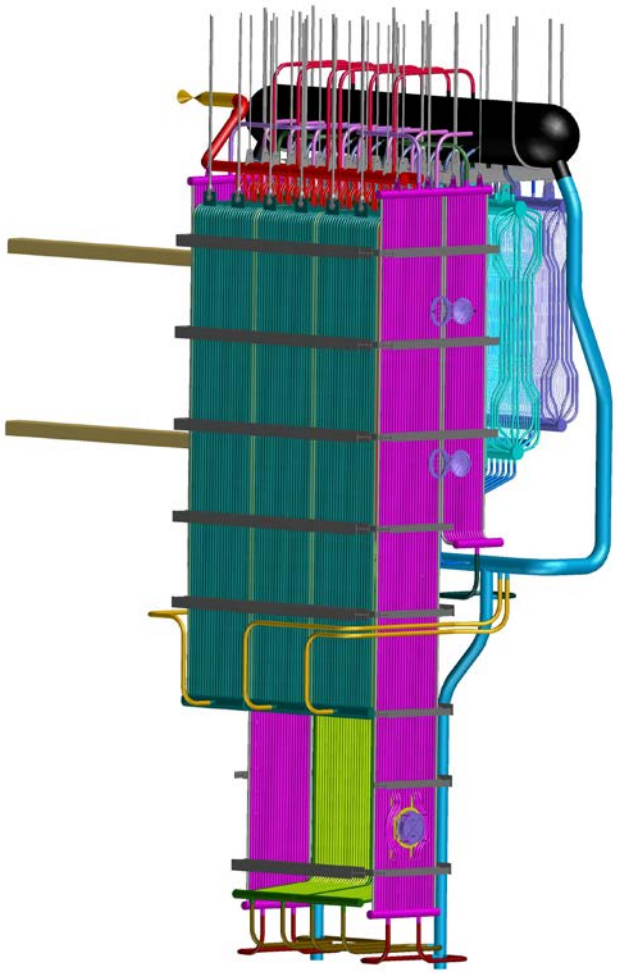
Boiler Specifications

- Steam flow: 111,900 lb/hr (14.1 kg/s)
- Steam pressure: 415 psig (28.6 bar)
- Steam temperature: 574F (301C)
- Waste heat from refinery fluid catalytic cracking (FCC) unit flue gas

Project Facts

A large Midwest refinery was looking to replace its FCC carbon monoxide (CO) boiler with a waste heat recovery unit (WHRU) to increase unit reliability and lengthen run time between outages.

The original unit was a circular furnace CO boiler design supplied by B&W in 1960 as an ASME Section I boiler. The original configuration included a pressurized circular two-drum furnace with 8 burners, 24 CO ports, and a continuous tube economizer above the drum elevation. The FCC unit had been upgraded to a full burn and the original burners had been idled decades before. The unit was experiencing excessive tube and casing leaks as well as increased maintenance to replace refractory.



As part of the customer's overall modernization at the facility, the FCC CO boiler was to be upgraded to B&W's updated design that increased boiler reliability and efficiency. The design basis also required a fundamental change to increase run time between outages. The design and fabrication were completed per ASME Section VIII Rules for Construction of Pressure Vessels. One advantage of this change was that the unit could now run 3 to 4 years longer between required internal inspections per the local jurisdictional requirements for unfired pressure vessels.

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Technical Design Features

The new B&W design incorporated the following:

RELIABILITY

Reduced Casing Leaks — The furnace enclosure is made of water-cooled tubes joined by thin membrane bars in an all-welded construction. The walls are gas tight and do not require an exterior casing to contain the products of combustion. This design eliminates the need for high-maintenance refractory casing seals, thus eliminating associated casing leaks and burn-through.

Increased Gas Pressure — The membraned furnace design and associated buckstay support system allows for higher gas-side pressure as well as resistance to wind and seismic loads. The buckstay system design reduces vibration from the FCC gas that enters the boiler at a velocity of about 150 ft/s (45.7 m/s).

Reduced Tube Leaks — The boiler tube reliability was improved by increased corrosion allowances, lower convection pass velocities, and erosion protection at the furnace inlet. The boiler design with membrane arch is optimized for low-velocity catalyst dust entrainment.

Reduced Drum Leaks — The one-drum, all-welded design eliminates the rolled tube connections associated with a two-drum generating bank, thereby minimizing water leaks as the integrity of rolled connections may diminish over time.

MODULARIZATION

Furnace Walls — The furnace walls were shop modularized, including inlet headers, side wall outlet headers, and rear wall/roof outlet headers, to facilitate installation and reduce outage duration.

Single Drum Generating Bank — The unit was converted from a two-drum generating bank to a single-drum design. This change allowed the supply of generating bank modules instead of a stick-built generating bank. The single drum design also allows for smaller generating bank modules to be quickly installed during turnarounds (TARs) rather than the extended outages typically required for retubing or replacing an entire two-drum generating bank.

Utilized Existing Structural Steel — The B&W design fit within the existing structural steel support columns, reducing material cost and construction duration.

Results

Increased Efficiency — With the economizer addition and improved heat transfer, the thermal efficiency of the boiler was improved.

Increased Unit Reliability — With the membraned furnace wall design, unit reliability is increased as deterioration of refractory on the tube walls and casing leaks are eliminated and the potential for wall tube failure is decreased. The improvements to the tube and drum design resulted in increased pressure part reliability.

Decreased Turnaround Maintenance Time — The boiler was designed for faster boiler cool down for confined space entry. Access was improved for ease of component inspection and repair. Components were designed for short TAR duration modular replacement.

The project achieved successful startup with all performance guarantees met. As of this writing, the unit has been continuously operating (4 years) without an outage or performance issues.

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