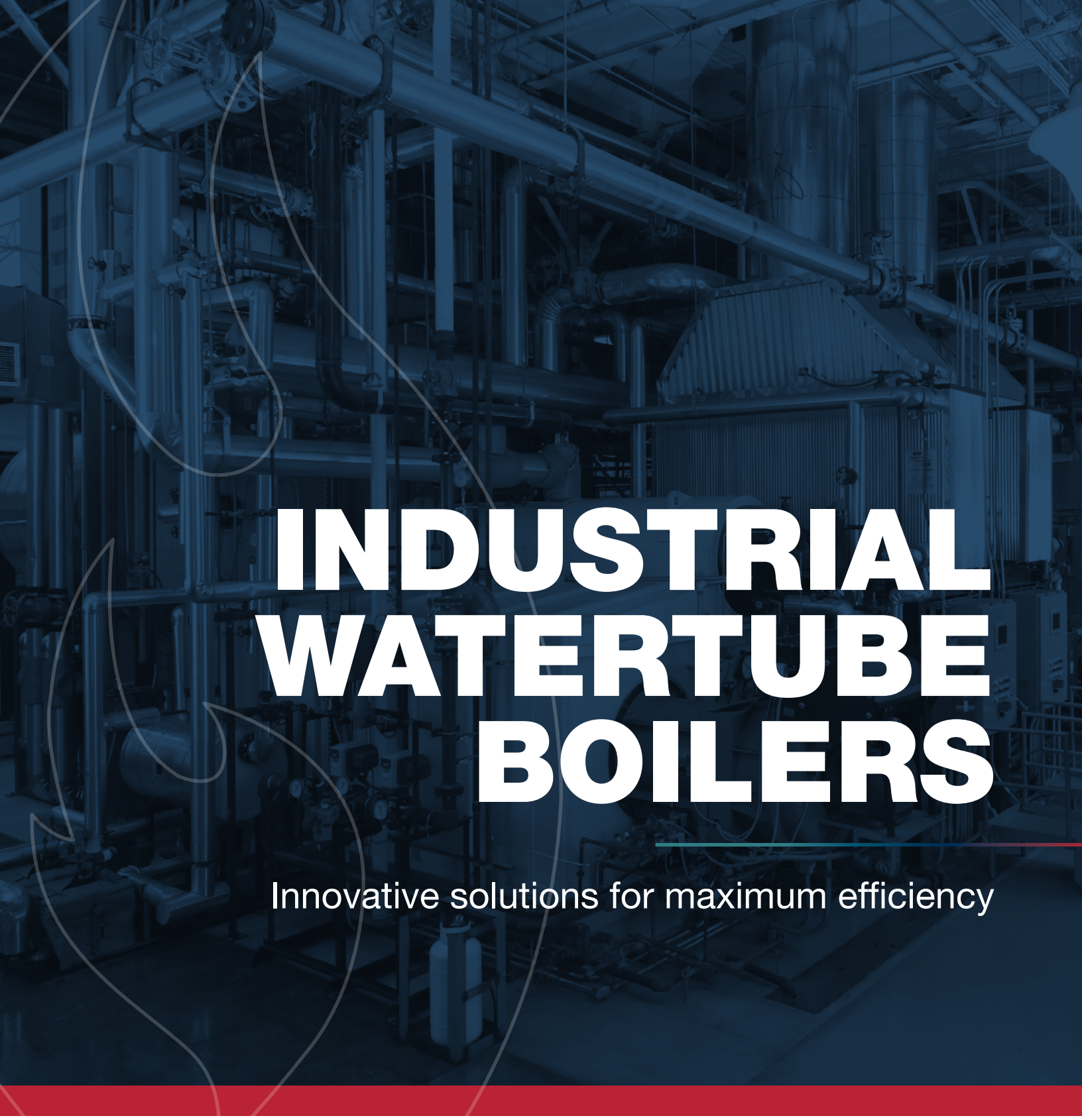


INDUSTRIAL WATERTUBE BOILERS

Innovative solutions for maximum efficiency

CleaverBrooks®

Total Integration from the Company that Pioneered It

Only Cleaver-Brooks offers totally integrated, single-source solutions for every aspect of your boiler system projects, from fuel inlet to stack outlet, custom built to meet your needs. We offer the industry's widest range of natural circulation watertube steam generators, and every aspect of our system is optimized for maximum efficiency, reliability and low emissions. We also offer supporting controls systems, heat recovery, exhaust stack solutions and complete aftermarket parts and service. Our uniquely engineered integration encompasses the entire boiler room and is designed to deliver the optimum in efficiency and environmental sustainability.

Every industrial watertube furnace utilizes an innovative welded-membrane wall design backed by more than 80 years of experience. And Cleaver-Brooks is the only manufacturer with refractory-free boiler wall construction, including the burner throat.

Our industrial watertube boilers meet the strict performance and sustainability criteria required to earn the Cleaver-Brooks Sustainability Seal.

Find out more at cleaverbrooks.com/sustainability.

Engineered Boiler Systems

Product Overview

D-Style	10,000 to 500,000 lb/hr Steam	Natural gas, refinery gas, #2 and #6 oil, alternative fuels, combination	Up to 1,800 psig	Steam, temperatures to 1,050°F	Available to <7ppm NOx* Ultra-low CO
A-Style	10,000 to 500,000 lb/hr Steam	Natural gas, refinery gas, #2 and #6 oil, alternative fuels, combination	Up to 1,800 psig	Steam, temperatures to 1,050°F	Available to <7ppm NOx* Ultra-low CO
O-Style	10,000 to 500,000 lb/hr Steam	Natural gas, refinery gas, #2 and #6 oil, alternative fuels, combination	Up to 1,800 psig	Steam, temperatures to 1,050°F	Available to <7ppm NOx* Ultra-low CO
Elevated Drum & Modular	200,000 to 1,000,000 lb/hr Steam	Natural gas, refinery gas, #2 and #6 oil, alternative fuels, combination	Up to 1,800 psig	Steam, temperatures to 1,050°F	Available to <7ppm NOx* Ultra-low CO
FC-OSSG	150,000 to 500,000 lb/hr Steam	Natural gas, refinery gas, #2 and #6 oil, alternative fuels, combination	Up to 2,500 psig	Saturated or superheated steam	Available to <7ppm NOx* Ultra-low CO
HRSGs	10,000 to 500,000 lb/hr Steam	Natural gas, refinery gas, #2 and #6 oil, alternative fuels, combination	Up to 2,300 psig	Steam, temperatures to 1,050°F	Available to <2ppm NOx* Ultra-low CO

*available to <2ppm NOx with SCR

Sustainability Solutions	IWT boilers can fire renewable natural gas, biogas and hydrogen. They achieve <2 ppm NOx with an ultra-low NOx burner and SCR equipment, and options are available to increase boiler efficiency by 5% on average.

CBCW

Cleaver-Brooks has pre-engineered 17 different configurations based on the most popular customer needs and applications. All you need to do is identify key performance parameters and choose options on your CBCW boiler system, and because of the work we've already done, we can deliver a solution tailored to your specifications easier and faster than ever before.

The CBCW utilizes Cleaver-Brooks proven D-style boiler, burner, and state-of-the-art HAWK control system. Cleaver-Brooks can provide truly customized Industrial Watertube boiler solutions faster than ever without the costs typically associated with a fast-track customized order.

Features

- Capacities from 10,000 to 225,000 lb/hr
- Design pressure up to 600 psig
- Saturated Steam

Benefits

- 17 pre-engineered options that make it easy to specify, purchase and install an industrial watertube boiler
- Complete set of technical documents for unmatched equipment and project delivery
- Each component can be customized to meet project and application needs
- Complete package includes boiler, system matched burner, controls, economizer and exhaust stack

Watertube Boilers

Cleaver-Brooks uses our experience and expertise to ensure every watertube boiler we manufacture is the highest quality in the industry and offers the lowest operational costs possible for that style of boiler. We leverage our specialized engineering expertise to deliver fully customized steam solutions that meet your specific needs. Our extensive range of watertube products, delivering from 10,000 to 500,000 lb/hr of steam, are available in D-, A- and O-style configurations.

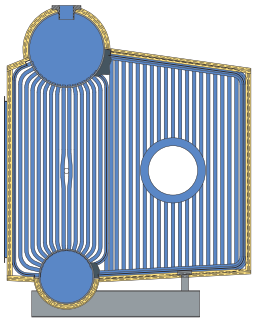
Both single- and dual-stage integral convective superheaters are available, and can accommodate Selective Catalytic Reduction (SCR) and CO catalyst. And you have your choice of firing natural gas, #2 and #6 oil, alternative fuels or a combination, available to <7ppm NOx.

Benefits

- Membrane wall constructions are 100% water-cooled and refractory-free
- Grooved tube seats for improved tube-to-drum attachment
- Large, water-cooled furnace areas feature refractory-free burner throat to optimize emissions performance and longevity and reduce maintenance
- Fully welded gas seals are used throughout to ensure gas-tight operation

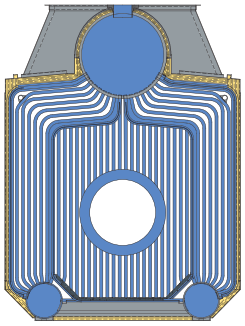
Features

- Capacities from 10,000 to 500,000 lb/hr
- Design pressure up to 1,800 psig
- Steam temperature up to 1,050 ˚F



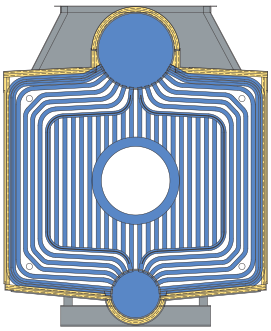
D-Style

The D-style is a 100% membrane water-cooled furnace, reducing costly, time-consuming, annual maintenance. The burner throat and the front and rear walls are welded and refractory-free, utilizing our burner design. D-style boilers can be customized to provide superheated steam. We offer both single- and dual-stage integral superheater systems with optional temperature control over turndown.



A-Style

The A-style design features a large, water-cooled furnace and an evaporator section with a low gas-side pressure drop that reduces fan power consumption. The vertical gas outlet minimizes the width of the overall package and allows for large steam capacities in restrictive footprints.



O-Style

This rugged design has become the true workhorse of the rental boiler industry. The vertical gas outlet on the O-style puts the economizer above the boiler, minimizing the width of the overall package. Its symmetrical design is ideally suited for mounting on a trailer for over-the-road transport. Cleaver-Brooks line of boilers for the rental industry continues to provide efficient and reliable service year after year, while withstanding rapid emergency startups.

Modular-Style Watertube Boilers

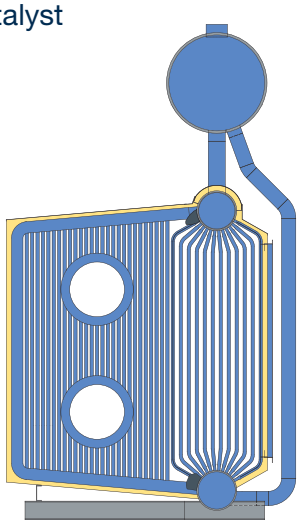
The Cleaver-Brooks elevated drum design maximizes shop assembly time while minimizing the cost of field labor often associated with boilers of such high capacity. The elevated drum design is a 100% membrane water-cooled furnace, reducing costly, time-consuming, annual maintenance. The front and rear walls are welded and refractory-free, as well as the burner throat, when integrated with A Cleaver-Brooks burner. Elevated drum boilers can be customized to provide superheated steam. We offer both single- and dual-stage integral superheater systems with optional temperature control over turndown. Our design allows for reduced gas-side pressure drop and smaller forced-draft fans and can accommodate Selective Catalytic Reduction (SCR) and CO catalyst.

Features

- Capacities from 200,000 to 1,000,000 lb/hr
- Design pressure up to 1,800 psig
- Steam temperature up to 1,050 ˚F

Benefits

- Minimal field assembly
- Faster, more cost-effective delivery time versus field erect boilers
- Reduced gas-side pressure drop and smaller forced-draft fans
- Superheated steam options available
- Dual burners available to meet specific applications
- Can accommodate Selective Catalytic Reduction (SCR) and CO catalyst



Elevated Drum Style

Forced-Circulation Steam Generator (FC-OSSG)

The Cleaver-Brooks FC-OSSG combines the benefits of a traditional D-style watertube boiler, with high saturated steam purity and very low blowdown, and the ease of cleaning once-through steam generators (OTSG). This large-capacity steam generator is uniquely suited for the needs of the heavy industrial, refinery and petrochemical markets. Specifically designed to work with MVC Evaporator produced water in Steam Assisted Gravity Drainage (SAGD) applications with typical water quality upsets. Available to <7 ppm NOx or higher and will fire natural gas, #2 and #6 oil, refinery gas, various waste streams from petrochemical processes or a combination.

Benefits

- Available in direct fired and heat recovery steam generator configurations
- Highly efficient steam solutions capable of meeting strict emissions requirements
- Increased efficiency with minimal blowdown
- 10:1 turndown in capacity with no additional process risks
- Single-source integrated boiler/burner/control package engineered to work together
- Smaller footprint for reduced material cost and space savings
- Shipped modular packages for ease of installation
- 100% mechanically cleanable by pigging

Features

- Capacities from 150,000 to 500,000 lb/hr
- Design pressure up to 2,500 psig
- Saturated or Superheated Steam

(Patented design)

Heat-Recovery Steam Generators and Waste Heat Boilers

With state-of-the-art, customized, packaged heat-recovery steam generators for gas-fired turbines from 1 to 100 MW, Cleaver-Brooks is a leading global provider of natural circulation-packaged and modular HRSG products for gas turbine, process exhaust, incinerator exhaust and hot water generation. We also manufacture Thermal Fluid Heaters (TFH), which incorporate a fluid-cooled membrane wall construction for the furnace and heating coil enclosure, creating a highly efficient, shop-assembled package. These units are available for most applications ranging from 20-200 MMBTU/hr. We have extensive experience customizing systems for your specific application. Our systems can increase efficiency for large-scale industrial applications such as thermal oxidizers, incinerators, FCCUs, thermal oil heaters, economizers and air heaters.

Benefits

- Multiple pressure units available
- External superheaters, economizers and feedwater heaters
- Compact design results in low installation costs
- Can accommodate Selective Catalytic Reduction (SCR) and CO catalyst

Features

- Capacities from 10,000 to 500,000 lb/hr
- Design pressure up to 2,300 psig
- Steam temperature up to 1,050 ˚F

Controls Systems

The Cleaver-Brooks approach delivers seamless, fully integrated and proven control packages that ensure optimized performance of the boiler plant. Cleaver-Brooks R & D team collaborates with plant engineers with their specific expertise and experience with boilers, burners, emission control, boiler plant auxiliaries as well as start up and commissioning to develop next generation integrated control systems. Our controls range from a cost-efficient, standard boiler-control logic and flame safeguard system to a custom-engineered package to meet specific customer requirements. Regardless of the level of complexity, we will provide state-of-the art hardware and programming for safe, reliable and efficient operation with a user-friendly interface. Cleaver-Brooks industrial watertube boilers are controlled by the HAWK Control System. Our control systems meet the latest NFPA, CSA, CE, TUV and GOST international codes and standards.

Features

- Burner Management System (BMS)
- Combustion Control System (CCS)
- Plant Master Panel
- Balance of Plant Controls
- Supervisory Control and Data Acquisition (SCADA)
- Auxiliaries
- Factory Accepted Test (FAT) and Site Acceptance Test (SAT)
- Fuel transfer, simultaneous firing, preferred fuel strategies
- Solid state, loop controller, PLC and DCS platforms
- Over 200 factory-trained technicians and local representatives specifically trained on HAWK control packages

HAWK Control Sytstem

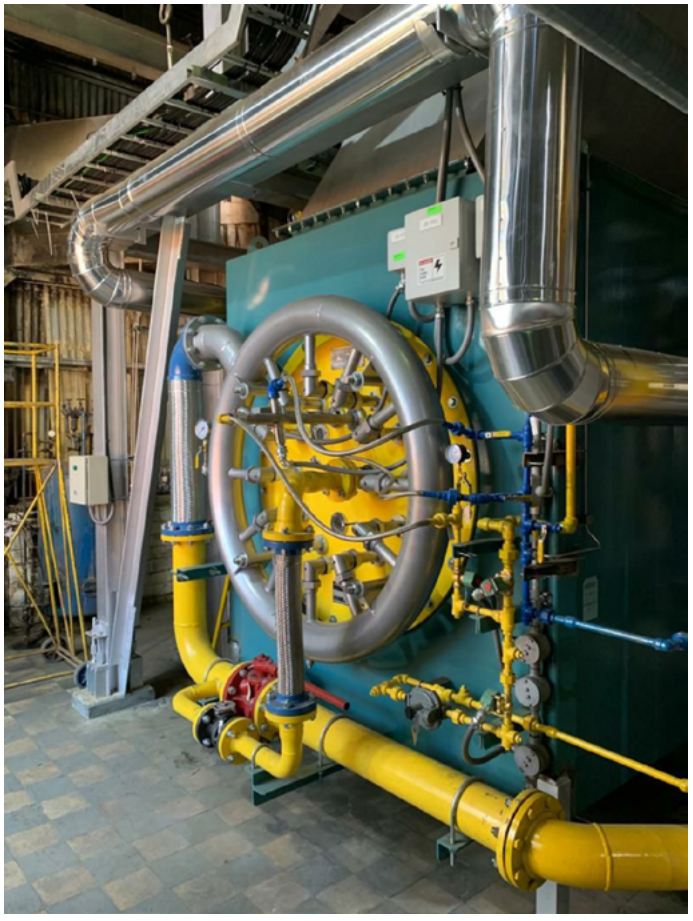
Cleaver-Brooks Burners

Every Cleaver-Brooks industrial watertube boiler is integrated with our burners, which are custom-built to exacting specifications to meet each application and furnace configuration, ensuring seamless integration and unmatched fit and finish.

Our advanced, in-house Computational Fluid Dynamics (CFD) modeling is the key to our revolutionary burner technology. Matching burner flame and furnace aerodynamics optimizes efficiency and lowers emissions without costly field tests. Simulations in a virtual environment provide calculations for fuel and air distribution in any furnace configuration. Our design provides ultra-low NOx, ultra-low CO and minimal particulate matter (PM) emissions.

Features

- Multi-fuels applications including natural gas, refinery gas, landfill gas (LFG) and other processed waste gases, light to heavy fuel oils, and liquid waste streams
- On-line adjustability and possible removal of individual gas injectors
- No refractory burner throat
- Unmatched flame stability with Center-Core technology
- NOx levels available to <7ppm with FGR and <30ppm without FGR
- Ultra-low excess air for high efficiency
- High turndown ratio of 40:1 on gas and 10:1 on oil



The power of total integration.

The **Power of Total Integration** is how Cleaver-Brooks delivers the world's broadest range of integrated, sustainable boiler plant solutions. In addition to our products, this includes our global representative and service network, training resources, and trusted expertise that add significant value to your Cleaver-Brooks investment.

CleaverBrooks®

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