



**PROVIDING PROCESS EQUIPMENT
SOLUTIONS TO CUSTOMERS FOR
OVER 160 YEARS**





160

YEARS OF EXCELLENCE

SINCE ITS INCEPTION, STRUTHERS WELLS™ has grown into an internationally respected name for reliable process heater technology and heat recovery equipment. Struthers Wells™ supplies superior engineering design, detailed project management, and precision manufacturing of equipment to the world's leading chemical, petrochemical, petroleum, and power (including solar) producers.

Founded as a manufacturer of pressure vessels, boilers, fired heaters and heat exchangers, Struthers Wells™ continues to be the standard of excellence for high temperature heating systems. Throughout its notable history, the company has designed and manufactured high temperature systems for every heat transfer fluid conceivable. More recently, Struthers Wells™ pioneered the development of solar steam generating systems, central receivers, and molten salt heat exchangers.

The extraordinary success of Struthers Wells™ is the result of a remarkable team whose depth of experience, knowledge, and commitment to embrace and protect the planet is unrivaled in the industry.

As one of the original founders of Tubular Exchanger Manufacturers Association (TEMA) and a charter member of the Heat Transfer Research Institute (HTRI), Struthers Wells™ continues to have access to the latest, most advanced technology for the design and manufacture of heat transfer equipment. The basis for many current computer programs used by industry leaders today is due to Struthers Wells™ contribution to the development of numerous standard mechanical, thermal, fluid, and vibration algorithms and calculation methods.

our history



1851 Struthers Wells™ established in Warren, PA as a foundry and manufacturer for the agricultural industry



1859 Oil was discovered at Drake Well in Titusville, PA and Struthers Wells™ became involved as a designer and fabricator of process equipment for the oil industry



1908 Struthers Wells™ produced the first all-welded carbon steel pressure vessel



1927 Struthers Wells™ started designing and supplying fired heater products



1940 Struthers Wells™ achieved worldwide recognition as a designer and fabricator of process and energy related equipment

- Designed and built the first Once-Through Steam Generator (OTSG) for enhanced oil recovery
- Developed the first forced circulation thermal fluid vaporizer
- Manufactured the first furnace used for thermal cracking of ethylene dichloride (EDC)
- Developed a convective-only titanium tetrachloride (TiCl₄) preheater/boiler/superheater utilizing metal tubes in lieu of unwieldy quartz tubes



1994 In 1994, the heat exchanger and fired heater technology of Struthers Wells Corp. was spun off to form Struthers Industries, Inc.



2005 In 2005, this technology was acquired by Thermal Engineering International (USA), Inc., a subsidiary of Babcock Power Inc., including all rights to the brand name Struthers Wells™.

STRUTHERS WELLS™ PRODUCTS

Struthers Wells™ line of products has an unparalleled reputation and successful history in the design and manufacture of fired heaters and heat recovery equipment for specialty heat exchangers.

Direct-Fired Process Heaters:

- General refinery and petrochemical heaters
- Thermal fluid heaters and systems
- Special petrochemical applications including EDC and Ketene pyrolysis
- Custom specialty heating applications
- Once-Through Steam Generators for oil-field applications

Heat Exchangers:

- Waste heat boilers
- Sulfur Recovery Units (SRU)
- Steam drums
- Specialty high pressure heat exchangers including breechlock closures
- Multi-wall pressure vessels and reactors

These products are commonly used in various process applications such as:

- Petroleum refining and upgrading
- Petrochemical and specialty chemical production
- Fertilizer production
- Syngas production



The Struthers Wells™ team has a continued history of providing innovative engineering solutions and technical support for new and existing applications of direct-fired process heaters and heat exchangers. Our capabilities include: repair, conceptual system redesign, replacement, diagnostic testing, performance analysis, cyclic analysis, failure analysis, condition assessment, thermal and structural analysis, design optimization, finite element analysis, solid modeling, piping flexible analysis, field modification, equipment re-rates, physical inspection, troubleshooting, and engineer and operator training.

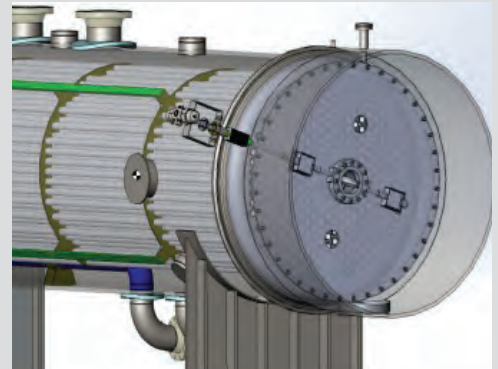


WASTE HEAT BOILERS

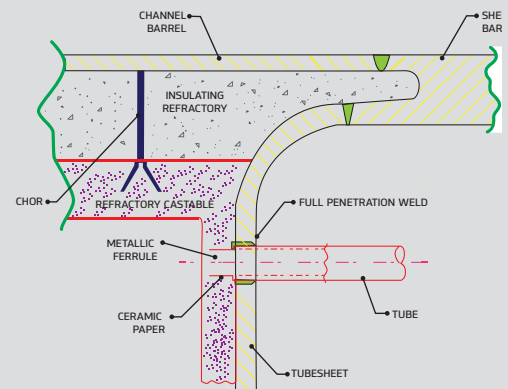
Designed to cool process gases above 2600°F (1400° C) and pressures above 3,000 psi (210 kg/cm²), Struthers Wells™ waste heat boilers generate high quality steam to pressures higher than 2,100 psi (150 kg/cm²) for steam generation rates up to 500,000 lb/hr (230,000 kg/hr). Designs include:

- Waste heat boilers
 - Single shell
 - Dual compartment
 - Internal by-pass

The flexible-supported-stayed-thin tubesheet design pioneered by Struthers Wells™ is typically 1" (25mm) thick. This allows good cooling by the water on the rear face lowering the tubesheet metal operating temperature. Tubes act as stays, remain at the same temperature, so the sheet stays flat. Flexible connection of tubesheet to shell allows for expansion and gives good fatigue resistance. In addition, the full thickness tube-to-tubesheet weld provides tubesheet integrity, eliminates crevice corrosion on the water side, and ensures equal metallurgy in the weld and on the tubesheet.



3D model showing the by-pass dampers and butterfly valve arrangement

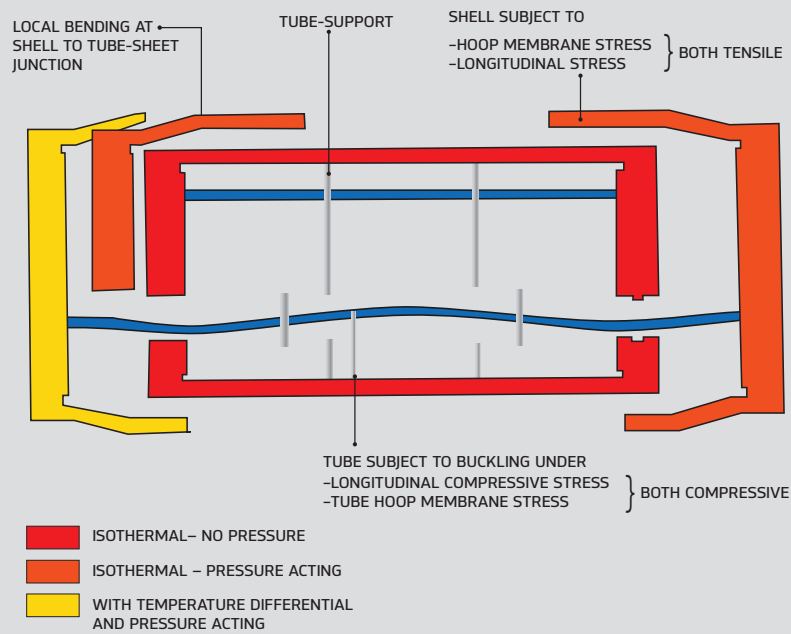


Thin flexible tubesheet

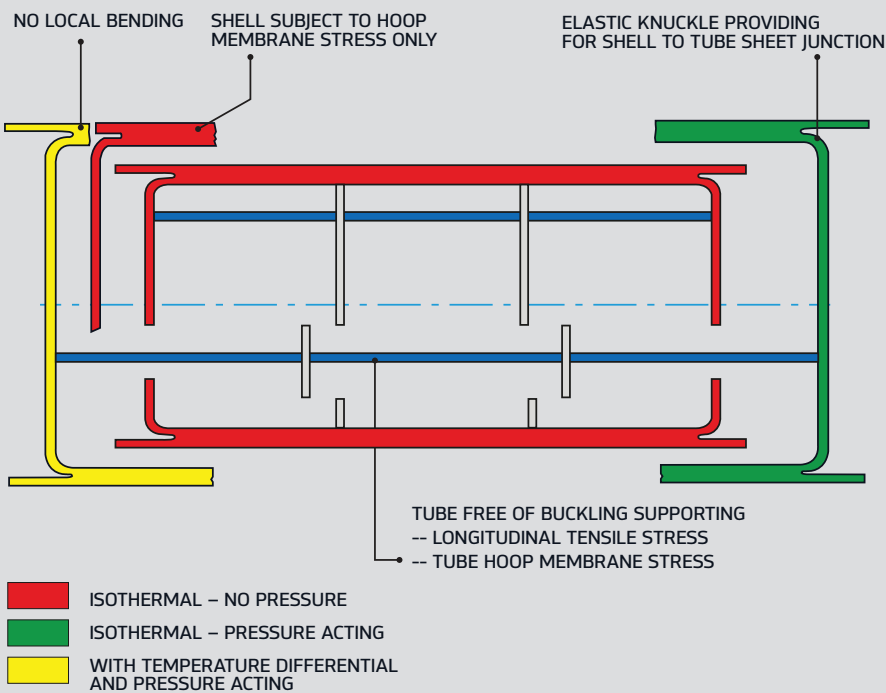


Process gas boiler for Torrance, CA

TYPICAL FIXED TUBESHEET VERSUS FLEXIBLE TUBESHEET DESIGN



Stresses in rigid, fixed tubesheet boiler designs



Flexible support tube-stayed, thin tubesheet boiler design

SULFUR RECOVERY UNITS (SRU)

Struthers Wells™ has extensive experience in supply of equipment for the Main Reaction and Incinerator packages, including:

- Burner (optional)
- Reaction furnace
- Waste heat boiler
- Steam drums
- Superheaters
- Sulfur condensers



Shop installed refractory



SRU main package in Salamanca Mexico



SRU main package for Qatar

STEAM DRUMS

Struthers Wells™ waste heat boilers are typically supplied with an overhead steam drum for water and steam circulation and a large recirculation rate to ensure effective cooling. Each steam drum has two-stage phase separation systems that provide steam used to generate power through steam turbines. Demister pads or Chevron vanes allow for steam-water separation.



Steam drum

HIGH PRESSURE HEAT EXCHANGERS

An industry leader in custom designed, specialized shell and tube heat exchangers for over 70 years, Struthers Wells™ has earned a hallmark reputation for quality and reliability in virtually every type of application and commercially available type of alloy. That expertise is again exhibited with high pressure heat exchangers.

Designed to withstand high pressures up to 7,900 psig (545 barg) and high temperatures up to 1600° F (870° C), Struthers Wells™ proprietary high pressure heat exchangers are available in sizes up to maximum shipping limitations.



Breechlock heat exchanger

BREECHLOCK HEAT EXCHANGERS

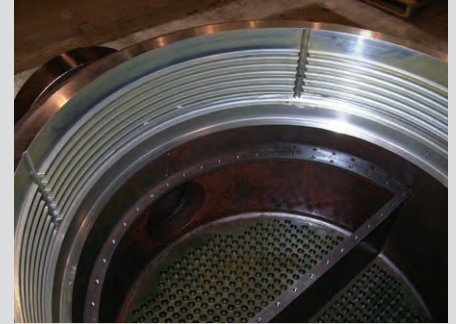
Shell and tube heat exchangers used on hydro-cracking and hydro-desulfurization require special closure design because of requirements imposed by the process licensor: Chevron & Union Oil.

In 1968, Struthers Wells™ participated in the design of a special heat exchanger for a major oil company to use in a hydrocracking process. Since then, Struthers Wells™ has adapted the basic concept of the breechlock closure to a number of heat exchangers with innovative new features that greatly improve closure reliability, including:

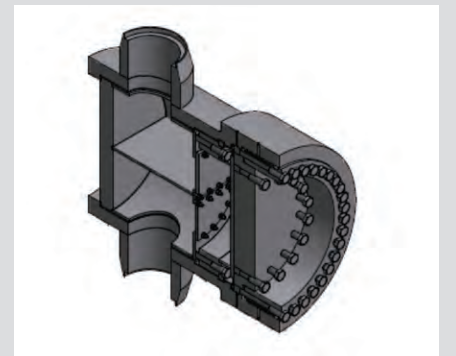
- Fully removable bundle
- Minimum number of leak paths to the atmosphere of high hydrogen content at elevated temperatures
- Tightening the internal gasket in service, eliminating leakage between shell and tube side fluids in feed/effluent, increasing the efficiency of the process

Our improvements to the original concept have resulted in dependable performance with benefits such as:

- No fluid pressure on the mechanical threads, thus avoiding hoop stresses and radial expansion at the threads
- Compensation for differential thermal expansion when temperatures of joint components vary
- Improved ACME thread that optimizes pitch and prevents potential binding issues
- Improved horizontal installation prevents scraped-off metal chips that can cause leaks in shell-to-tubesheet gasket
- Forces on the threads are purely mechanical



Breechlock enclosures





Installation of Struthers Wells™ fired heater

FIRED HEATERS

AVAILABLE HEATER CONFIGURATIONS INCLUDE:

- Cylindrical
 - Vertical or horizontal
 - Serpentine or helical radiant coils
 - Multi-cell arrangements
- Box/Cabin
 - Vertical or horizontal tube arrangements
 - Single or double firing
 - Serpentine and arbor/U-tube coil arrangements
 - Multi-cell arrangements
- Convective-only arrangements

Struthers Wells™ provides direct-fired process heaters and thermal fluid heating systems to chemical, petrochemical, petroleum, and power producers.

The history of Struthers Wells™ encompasses nearly a century of innovations such as the first forced-circulation Dowtherm® vaporizer in 1942, the first ethylene dichloride (EDC) thermal cracking furnace in 1955, and the first Once-Through Steam Generator (OTSG) in 1960. With over 1,000 installations now in operation, Struthers Wells™ brand systems are at work around the world, delivering high temperature heat at relatively low pressures to a wide variety of processes in petroleum refining, petrochemical and thermal fluid heating applications.

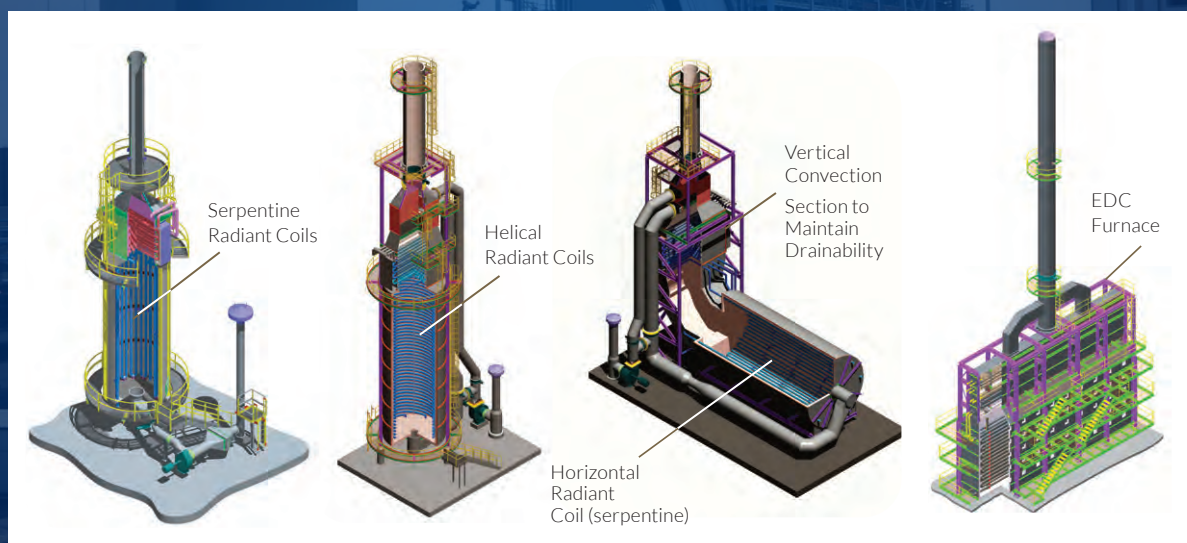
DIRECT-FIRED PROCESS HEATERS

The Struthers Wells™ brand of fired heaters has a tradition of superior products and services with a full-service engineering design and project management staff. Fired heater products include:

- Hot oil/thermal fluid heating (liquid and vapor service)
- Crude/vacuum heaters
- Hydrotreater heaters
- Hydrocracking heaters
- Ethylene dichloride pyrolysis
- Ketene pyrolysis
- Steam superheaters
- Catalytic reformer heaters
- Reboiler heaters
- Others as required



Struthers Wells™ process heaters



The core products within the Struthers Wells™ product line are cylindrical radiant/connective style heaters, either horizontal or vertical, with either helical or serpentine radiant coils. Cabin/box arrangements with vertical or horizontal radiant coils utilizing wall- or floor- or end-firing are also available. With state-of-the-art design tools and applications, Struthers Wells™ offers:

- Detailed thermal-hydraulic design and analysis of fired heaters and process furnaces
- Engineering studies to evaluate and assess revamp opportunities to maximize heater performance
- Structural analysis and mechanical design
- Code capabilities (API 560, ASME BPVC Section I or Section VIII, ASME B31.1)



Struthers Wells™ uses design tools including both in-house proprietary, commercial and advanced computer-aided engineering (CAE) tools and applications to ensure technically sound heater design in a timely manner.

CAPABILITIES

- Detailed thermal-hydraulic design and analysis of fired heaters and process furnaces
- Engineering study to evaluate and assess revamp opportunities to maximize heater performance including:
 - emissions reduction through upgraded low NOx burners, or the addition of flue-gas-recirculation (FGR)
 - thermal efficiency upgrades via addition of combustion air pre-heater
 - fuel switches, and much more

RESULTS

- Structural analysis and mechanical design
- ASME code capabilities include API 560, ASME BPVC Section I or Section VIII, ASME B31.1
- Complete fuel system design including burner design and selection, fuel delivery valve trains Burner Management Systems (BMS) and heater controls
- Capability to engineer a heater with all necessary auxiliaries for a circulating fluid system such as expansion tanks, circulation pumps, piping, valves, etc.



Struthers Wells™ horizontal thermal fluid system

THERMAL FLUID HEATING SYSTEMS

FEATURES

- High-efficiency crossflow convection tube banks combined with radiant furnace coil
- Optional combustion air-preheat systems
- On-line cleaning with soot-blowers available as required
- Available in a variety of arrangements to suit most applications
- Available with a variety of options for combustion systems to meet project needs

BENEFITS

- Capable of 90% (LHV) thermal efficiency
- Customized design allows optimization for project constraints such as available plot area
- Low emissions with proper flame development
- Heat fluxes optimized to ensure film temperatures do not result in significant fluid degradation
- Easy access to furnace for inspection and maintenance

To ensure that a thermal fluid heater is best suited to an application, Struthers Wells™ offers numerous options. Radiant coil choices include:

- Vertical serpentine coils – the most rugged flexible designs
- Horizontal serpentine coils – inherently drainable; ideal for access to instrumentation from grade
- Vertical helical coils – inherently drainable when vertical; preferable for freeze-prone liquids such as molten salt or liquid metals

Vertical heaters allow the smallest possible footprint area and all components are oriented for direct flow of flue gas from burner to stack. This saves valuable plot area and eliminates the need for a freestanding stack.

Cross-flow convection tube banks are also available for every thermal fluid system to increase thermal efficiency. For even higher thermal efficiencies, Struthers Wells™ can supply an air preheater system – optimized to the particular fuel(s) being burned to boost efficiency to over 90%. Air preheaters can be shell-and-tube exchangers or crossflow tubular exchangers configured to meet any need.

All thermal fluid system designs can have on-line cleaning by sootblowers for dirty fuel applications, eliminating the need to shut down for water wash or steam clean.

Struthers Wells™ also provides cabin and convective heaters which allow for easy inspection and maintenance. Cabin heaters are typically for large sizes and have a modular design for quick field assembly. Convective styles have a combustion chamber and flue gas recirculation for controlled, uniform heat flux.



| ONCE THROUGH STEAM GENERATORS (OTSG)

Struthers Wells™ is the original designer of the Once Through Steam Generator for application in thermal Enhanced Oil Recovery (EOR), which has been the standard for the industry for decades. Used throughout the world to enhance oil recovery in heavy crude reservoirs and oil sand deposits, OTSGs inject steam into target areas that often impose demanding and stringent operating conditions. The Struthers Wells™ OTSG is supported by our extensive field experience, advanced technology, and laboratory driven engineering data.

The OTSGs are easy to maintain and continue to operate reliably, primarily unattended, or with minimum supervision. Features of the OTSG include:

- Handles zero-hardness feedwater with high total-dissolved solid contents
- Responds to rapid and significant changes in load demand as dictated by the injection well while maintaining steam quality
- Operates through a wide range of steam pressures at a high thermal efficiency rate

In order to meet high production demands and operating requirements of any heavy oil field recovery project, Struthers Wells™ offers both standard and custom designed steam generators from 25 to 300+ MMBtu/hr. Trailer-mounted systems that range in size from 5 to 40 MMBtu/hr are fully self-contained and can easily be moved from one field to another.

Advanced technology that improves operational reliability, coupled with custom, cost-effective designs, enables us to provide today's plant operations with the most sophisticated products in the industry.



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