



HEAT EXCHANGER BELLOWS

Engineered Solutions For Pipe Motion



www.thorburnflex.com

Thorburn Engineering & Site Services



Engineering Capabilities & Experience

Thorburn's design engineering expertise is supported by advanced FEA software that offers powerful and complete solutions for both routine and sophisticated engineering problems. Thorburn's engineers can analyse and provide innovative solutions for pipe and duct motion problems including dynamic vibration, nonlinear static, linear static, thermal gradient through material wall thickness, acoustic impedance and fatigue using a common model data structure and integrated solver technology.

Design Tools & Capabilities

- Finite Element Analysis (FEA)
- Pipe stress analysis
- CAD & Solidworks
- 3D Modeling
- Mathcad

Team Thorburn can provide answers to piping and ducting problems by performing piping stress and finite element analysis, on-site measuring the results against the actual failure mode. Our services include...

- Quality verification of installation before start up
- On-site consultation, engineering & training sessions
- Maintenance service during shutdowns & turnarounds
- Refurbishing, retrofitting, repairing & replacements
- Guidance in the installation & maintenance
- Stress analyses to verify design

Bellows Manufacturing Capabilities

Welding and Fabrication Capabilities

- Arc, pulse arc, TIG, micro TIG, micro plasma, MIG, core wire, laser
- Tube welding, automated and track welding, automated flame cutting and hydro cutting
- Rolls, positioners and turntables
- Automated fitting to end joints welding DIN 6mm (1/4") to DIN 300mm (12")
- Automated hydro-forming convolution heights DIN 25mm (1") to DIN 600mm (24")
- Spinning lens style forming convolution heights up to 600mm (24")
- Hydro-forming lens style convolution heights (with no crest weld) up to 250mm (10")
- Mechanical forming convolution heights DIN 25mm (1") to DIN 9000mm (360")

NDT/NDE Programs & Design Verification Testing

- Weld X-Ray to 300KV-5MA / welds dye penetrant to ASME Sec V
- Vacuum testing 760mm (29.9") HG and hydrostatic or nitrogen pressure testing to 1,000 bar (15,000 psi)
- Destructive design verification testing to 4000 bar (60,000 psi)
- Impulse Testing to 680 bar (10,000 psi) at 204°C (400°F).
- Burst testing up to 10,000 bar (150,000 psi)
- Pliability fatigue and deflection testing ISO 10380:2012
- Seismic and vibration analysis in acceptance with ASME Sec III
- Helium mass spectrometer leak testing



Series SF Single Flex Bellows For Heat Exchangers

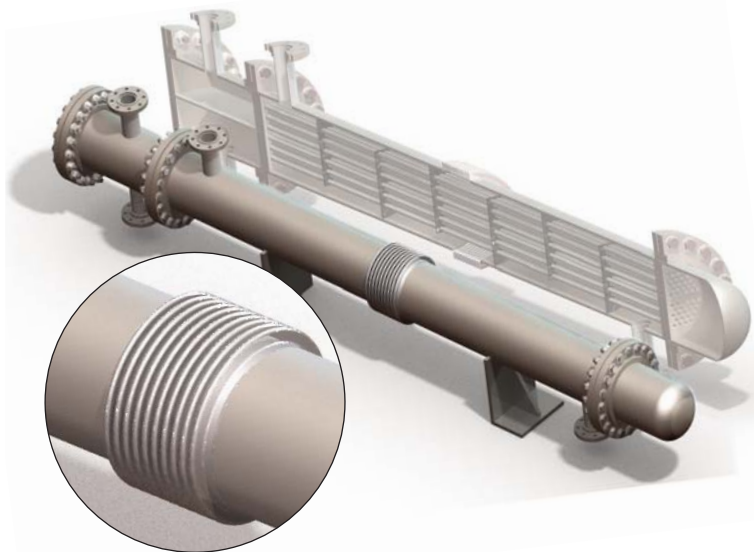


Thorburn Series SF Single Flex tied bellows installed on a heat exchanger

Thorburn thin wall multi-convolution expansion joints provide a leak tight seal and neutralizes all problematic differential movements in fixed tube sheet heat exchanger applications such as, tube buckling, media contamination caused by tube failure and excessive tubesheet stress and tube-to-tubesheet weld failure, etc.

Thorburn's Expansion Joint Advantages

- Registered and meets all ASME Section VIII, Div.1 Appendix 26 requirements
- Materials include austenitic stainless steels, high nickel alloys, zirconium, titanium, AL6XN, Alloy 20 and all other ductile code acceptable materials
- No circumferential welds providing a higher fatigue life
- External covers supplied preventing costly mechanical damage to the heat exchanger
- Welders and welding procedures to ASME Section IX
- N.D.E. to ASME Section V
- P.E.D. (Pressure Equipment Directive) certification available upon request
- Designed to mate with T.E.M.A. heat exchanger designs

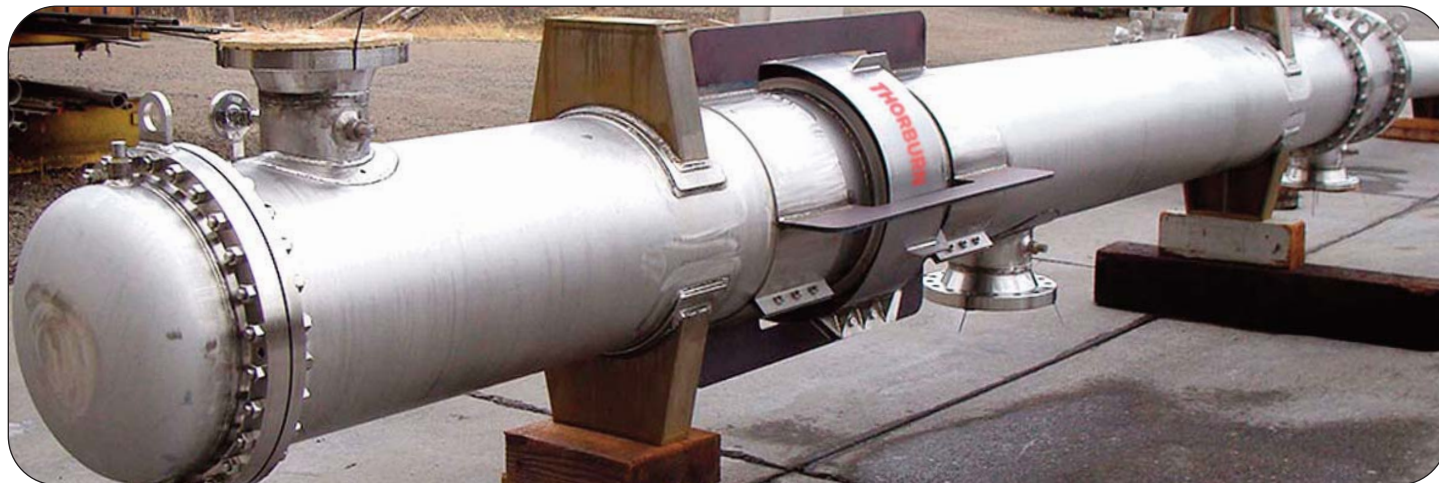


Thorburn Series SF Single Flex bellows conforms to EJMA B31.1, B31.3 and ASME Sections III, VIII, PED



Thorburn's thin wall bellows expansion joints are most commonly found on T.E.M.A., AEM, BEM and NEN fixed tubesheet heat exchangers such as the one shown above. Thorburn can also provide bellows for tube side heat exchangers for customized floating head heat exchangers e.g. AET & BET configurations

Series TB Toroidal Bellows Expansion Joints



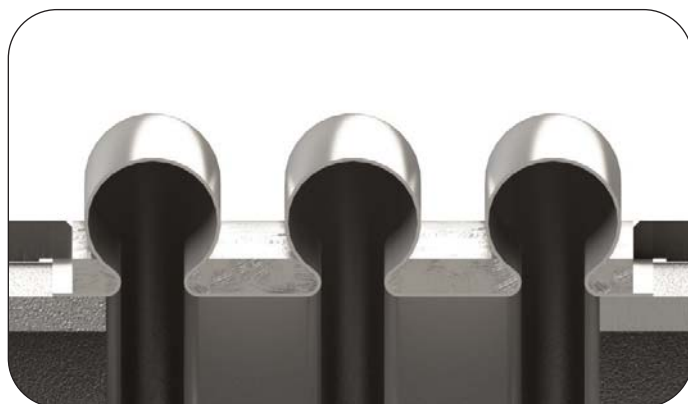
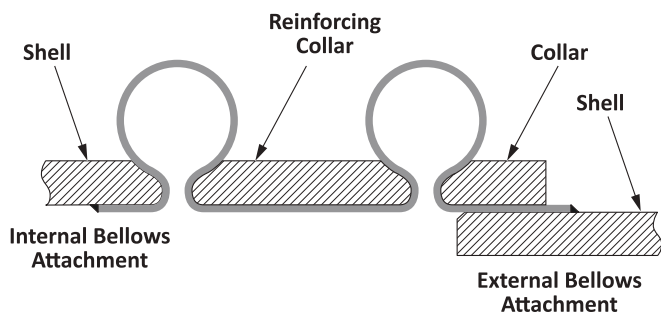
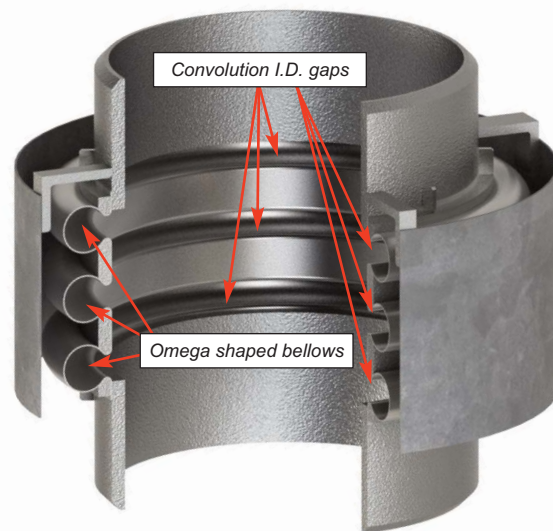
Toroidal bellows installed on a heat exchanger

Designed for High Pressure Applications

Thorburn's Series TB toroidal bellows consists of a circular tube wrapped around weld ends or pipe ends having a small gap at the I.D. to permit axial stroke. Thorburn's Series TB toroidal expansion joint bellows are Omega shaped (Ω) and are hydro formed with very high pressure presses. The Omega shape of the bellows increases its stability in very high pressure applications. Its high pressure resistance is due to the absence of bending stress in the side walls of the bellows, which is the single most limiting factor for the conventional "U" bellows profile.

Thorburn's Series TB toroidal bellows are hydraulically formed and have a minimum number of longitudinal weld seams which are the same thickness as the parent material and cannot act as a focal point for stresses.

Thorburn's Series TB toroidal bellows are designed for Heat Exchangers in accordance with ASME Sec VIII, Div 1, App. 26. The low convolutions height reduces the pressure thrust on the tubular plates of the exchangers, especially when compared to flanged and flued type bellows.



Cutaway of Thorburn's multi-convolution Omega shaped bellows

Thorburn Series AF High-Core Bellows Expansion Joints



Thorburn Series AFU High-Core bellows expansion joints fully assembled

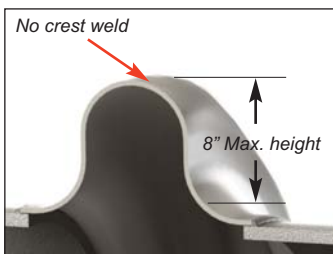
Series AF High-Core Bellows

Thorburn Series AF High-Core bellows are characterized by a higher convolution profile and a thicker ply construction than traditional bellows expansion joints. Series AF bellows are typically composed of a single or multi-convolution with a bellows height of 80mm (2") to 600mm (24"). Thorburn AF Series bellows are manufactured by a spinning process, referred as lens style bellows (Series AFS) or a hydroforming process (Series AFU). The bellows are made from a single ply thickness from 1.5mm (1/16") to 6mm (1/4"). Available with welded or flanged ends. Thorburn Series AF bellows expansion joints are found mainly in ducting systems in acid plants and fixed tube sheet heat exchangers to accommodate thermal growth. In fixed tube sheet heat exchangers, Thorburn AF bellows are fabricated from steel plate of the same material and thickness as the shell barrel.

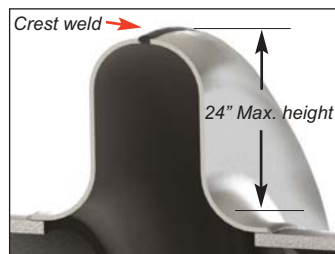


Manufacturing a Thorburn Series AFS single convolution lens High-Core bellows

Thorburn High-Core Bellows Profiles



Thorburn Series AFU hydro-formed bellows



Thorburn Series AFS spun bellows

Advantages Over Thin Wall Bellows

- Holds up better to mechanical damage
- Facilitates weld repair
- Performs better to corrosive media attack

Special Applications

- Heat Exchangers
ASME Sec.VIII, Appendix 5
(circumferential welded convolutions)
ASME Sec.VIII, Appendix 26
(for U-shaped and Omega shaped bellows without circumferential welds)

Thorburn Series AFS High-Core Lens Bellows Expansion Joints



Thorburn Series AFS High-Core bellows expansion joints ready for shipping



Bellows spinning machine forming a Thorburn lens style bellows

Thorburn Series AFS Spun Lens Style Bellows

Thorburn AFS bellows are made from welded thick metal disks that are made into donut like shapes. The AFS convolution profile is formed first by spinning the outside edges of the donut in one direction, sometimes referred to as a flange, then spinning the other direction of the donut, which is referred to as a flued. The shape of the profile after spinning resembles the letter "S". The final step in making a Thorburn AFS convolution is done by welding the two "S" halves together. The expansion joint assembly is made by welding a pipe end to the roots of the welded "S" shaped convolution.

Thorburn AFS construction

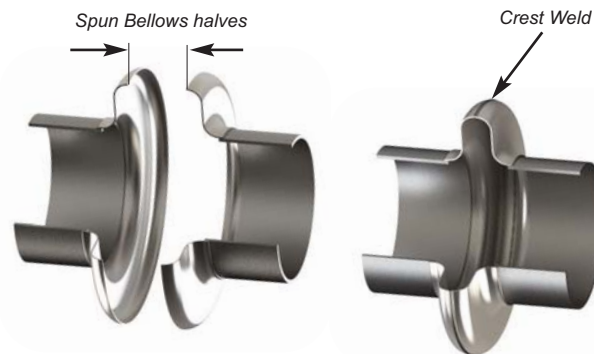
- Typical convolution height: 80mm (3") to 600mm (24")
- Thickness: 1.5mm (1/16"), 2mm (5/64"), 3mm (1/8"), 5mm (3/16"), 6mm (1/4")
- Materials: 304H, Inconel 625, 316H, 316L, 321



Welding a Thorburn Series AFS single convolution lens High-Core bellows



Thorburn lens bellows installed on a heat exchanger



Lens type bellows consisting of two spun halves joined together with a crest weld

Thorburn Series AFU High-Core Hydro-Formed Bellows



Welding a Thorburn Series AFU Inconel 625 250mm height single convolution bellows expansion joint without crest weld

Thorburn Series AFU High-Core Hydro-Formed Bellows

Series AFU High-Core bellows are manufactured by hydroforming in one piece without a crest weld. Series AFU bellows can be formed with a single convolution or multi-convolution configuration with no root weld. Thorburn's large hydroforming presses (as shown in the photo at right) can make convolutions with materials up to 3mm (1/8") thick and heights up to 250mm (10"). Thorburn AFU bellows can be made with multiple convolutions all in one piece. This process provides greater design flexibility and cycle life and dramatically reduces installation costs. Series AFU High-Core bellows can be supplied with ASME "U" stamp code verification.

In corrosive applications, SS304 or SS316 can be upgraded to alloy 625 to provide better corrosive resistance. When heat exchangers are insulated, Thorburn's AFU bellows can be designed with smaller heights to make it easier to insulate in the field.



Single Convolution Series AFU on a shell and tube heat exchanger



Thorburn's large hydroforming press making large multi-convolutions up to 4 meters with convolution heights up to 250mm (10 inches)

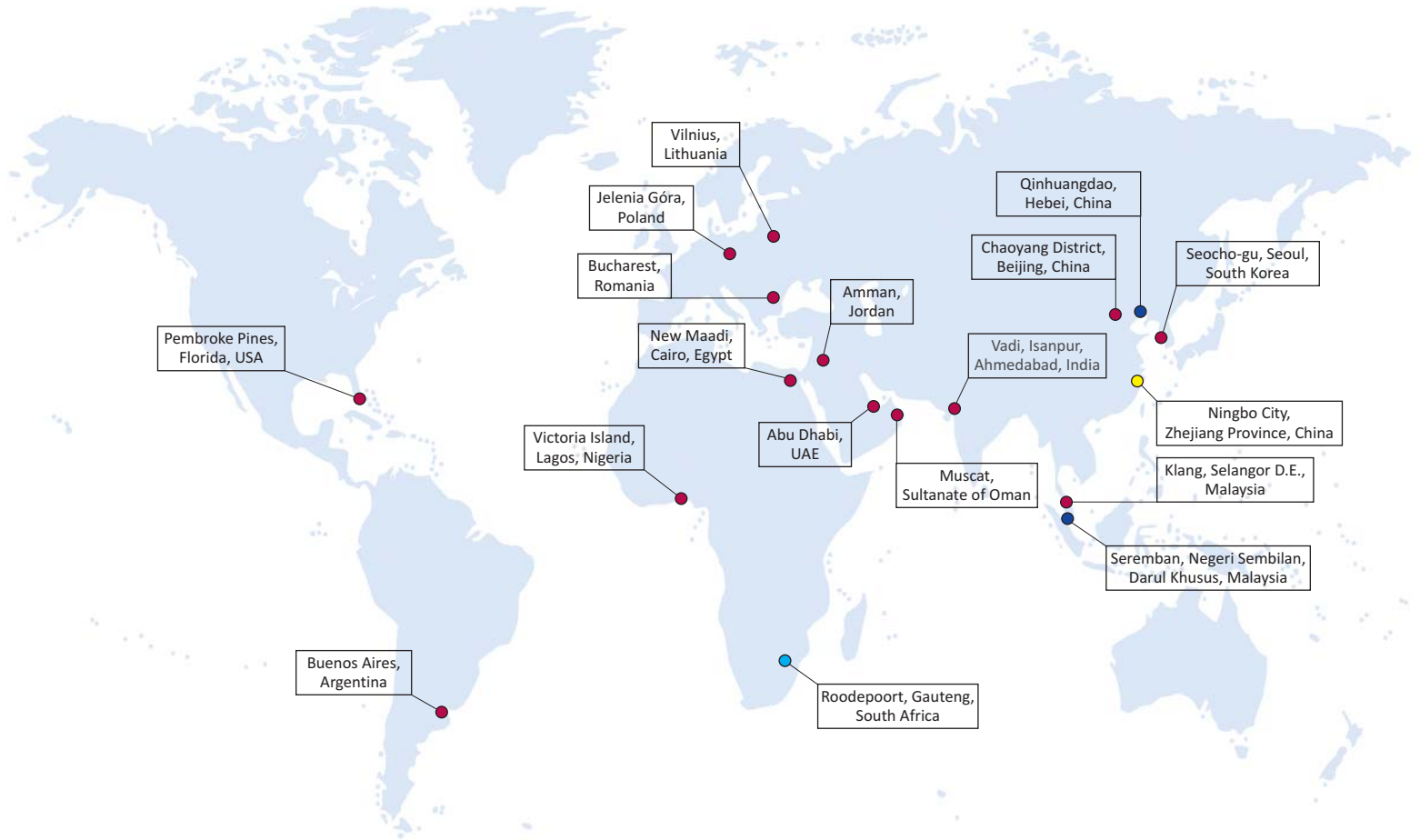
Construction Features

- Convolution Height: 50mm (2") to 250mm (10")
- Single Ply (Standard)
- Thickness: 1.5mm (1/16"), 2mm (5/64"), 3mm (1/8")
- Single or multi-convolutions, multi-ply
- Hydro-formed in one piece with no crest weld
- Low spring rates, greater movement
- Low overall cost

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