Guide to Alfa Laval Packinox heat exchangers

Leading in heat transfer technology

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Alfa Laval Packinox Introduction

Almost 3 decades of experience has made Alfa Laval Packinox S.A.S. the world leader in large welded-plate heat exchangers for the hydrocarbon industry.

Using its unique proprietary technology and manufacturing process, Alfa Laval Packinox designs, develops and fabricates heat exchangers with an extensive array of end-user benefits.

Beginning in heat transfer for catalytic reforming, Alfa Laval Packinox soon gained recognition as an industry standard and has experienced continuous growth and development.

With its proven technology, Alfa Laval Packinox has won industry recognition in a wide range of applications.

Alfa Laval Packinox's outstanding list of references in new units and debottle-necking revamps includes engineering contractors and end-users in such processes as catalytic reforming and hydrotreating, as well as paraxylene production.

More than 300 Alfa Laval Packinox heat exchangers have been installed throughout the world, with nearly 140 in the Asia-Pacific region, 85 in Europe and the CIS, 49 in the Americas, and 67 in the Middle East, Africa and the Indian subcontinent in a range of processes from catalytic reforming to linear alkylbenzene and more.

Photo: Emmanuel Joy/Framatome

Packinox assembly hall at Chalon-sur-Saône

Significant resources are allocated to R&D in an ongoing commitment to keep apace of the industry. Alfa Laval Packinox's staff of thermal and mechanical engineers performs the research and analysis necessary to ensure that every Alfa Laval Packinox heat exchanger offers the highest efficiency and reliability.

Their tools include in-house PASHA software, a powerful program for calculating optimum design and predicting the effects of diverse operating conditions on the performance of Alfa Laval Packinox heat exchangers.

Proven efficiency and performance

The cutting edge technology of Alfa Laval Packinox heat exchangers ensures optium performance and reliability in even the most demanding operating conditions.

In 1980, Afa Laval Packinox made the breakthrough which successfully combines the high temperature, high pressure performance of shell and tubes with the thermal and hydraulic efficiency of plate technology in a compact, large capacity design.

Diverse applications
Because Alfa Laval Packinox exchangers withstand extreme temperatures at high pressure, they are suited to a variety of services.

Photo: Alain de Baudus/Framatome

One of the largest Packinox exchangers, for paraxylene production in india

Alfa Laval Packinox Applications

Listed below are some of the applications for which Alfa Laval Packinox has commercial references. (See the Alfa Laval Packinox reference list for further information.) For other applications, please contact us for a feasibility/cost study.

1 – Feed / Effluent technology

- Catalytic reforming (continuous regeneration and fixed bed)
- Hydrotreating/Hydrodesulfurization (gasoil, naphtha and kerosene feeds, pyrolysis gasoline)
- Paraxylene plants (xylene isomerization, toluene disproportionation units)
- Paraffin dehydrogenation for LAB plants
- Methanol synthesis loop (feed/effluent converter preheater)

2 – Non feed / Effluent technology

- Stripper Bottoms Heat Exchanger for hydrotreating
- Ziepack condensers and reboilers
- Multi-stream applications (MTBE Reactor Effluent Chiller)
- ProserPack heat exchanger plus gas-liquid separator for condensate recovery loops/dew point control units

Photo : Mitsui Chemicals / Mitsui Sekka Engineering

A Alfa Laval Packinox heat exchanger for pyrolysis Gasoline hydrogenation

Overview

Photo : R. Quatrain / Framatome

A standard combined feed/effluent heat exchanger en route for a catalytic reforming unit

Alfa Laval Packinox custom-designed heat exchangers offer higher thermal efficiency, lower pressure drop and superior compactness to meet customer demand for:

• Less capital outlay
- lower installation costs (potentially fewer exchangers, less spending on associated piping and valves, transportation, etc.)
- downsizing of surrounding equipment (fired heaters, compressors, air coolers, etc.)

• Lower operating costs
- energy savings, for example on fired heaters, compressors, and air (or water) coolers
- possibility of improving reaction yield by optimizing conditions at the reactor

• Less spending on upkeep
- high fluid turbulence means less fouling and fewer cleaning requirements
- accessibility for maintenance is facilitated by top and bottom end manholes
- fewer flanges means fewer potential points of leakage to inspect

• Clean, safe operation
- double-containment design minimizes the risk of leakage and attendant fire hazard
- by allowing other equipment to burn less fuel, Alfa Laval Packinox keeps harmful emissions to the atmosphere in check

• Quick payback
- Alfa Laval Packinox can replace existing tubulars for economical debottlenecking revamps with no costly change to other main components such as furnaces, compressors, air/water coolers.

Process optimization via improved heat recovery integration is one solution to trimming a unit's overall costs. In general, Alfa Laval Packinox heat exchangers are effective solutions when the process requires at least one of the following:

- *High thermal efficiency*
- *Low pressure drop (ΔP)*

Total ΔP usually ranges from 0.35 bar to 1.5 bar (total flange-to-flange, both sides).
For applications where lower ΔP has a major impact on costs, total ΔP design value can be as low as 0.05 bar.
- Extensive heat exchange area in a single compact unit

To achieve maximum savings, it is best to consider Alfa Laval Packinox heat exchangers at the earliest stages of the basic engineering design.

Alfa Laval Packinox offers these guidelines for preliminary information only.
Overall financial balance should be analyzed in terms of capital and operating costs of the unit as a whole, site and equipment constraints (revamps or new units), and overall process optimization.

Technology for feed/effluent applications

Description:
Alfa Laval Packinox combined feed/effluent plate heat exchangers comprise a welded bundle block and a pressure vessel.

Heat transfer takes place exclusively within the bundle block so that no process fluids circulate inside the shell. The pressure vessel is filled with higher pressure fluid for compression of the bundle block. Bundle plates are exposed only to the differential pressure of the flowing fluids; thus Alfa Laval Packinox heat exchangers operate safety even in high pressure applications.

Installation:
In general, Alfa Laval Packinox heat exchangers are installed in an upright position (the pressure vessel is fitted with a skirt or brackets) within minimal footprint.

Current size range:
Shell diameter: 1 m to 6 m (3 to 18 ft.) Shell total length: 10 m to 20 m (30 to 65 ft.) Total weight: 30 to 300 metric tons (60,000 lb. to 600,000 lb.) Equivalent S&T surface area: 1 000 to 27 000 m^2 (11,000 to 297,000 sq. ft.) in a single shell.

Construction materials:
Bundle: Stainless steel (SS 321, SS 316, SS 304, etc.) and carbon steel. Qualified construction materials include all types of austenitic stainless steel in addition to titanium and highly corrosion resistant 6 Mo austenitic SS Vessel: 1.25 Cr - 0.5 Mo, 2.25 Cr - 1.0 Mo, stainless steel, carbon steel or other as per customer requirements Bellows: Inconel, Incoloy or other, subject to demand.

Pressure & temperature operating limits:
Temperature:
Typical design temperature range is 300°C - 550°C (1,000°F).
Design temperature as high as 650°C (1,200°F) has been achieved.
Note: internal bellows compensate for thermal differential expansion.

Pressure:
The pressure vessel is designed to withstand operating pressure; design pressure is no obstacle for Alfa Laval Packinox heat exchangers.
Our reference list includes exchangers with design pressure ranging from 3 bar to 120 bar.
Differential pressure between feed and effluent is the bundle's only mechanical limitation. As a conservative measure, we currently limit this value to 40 bar.

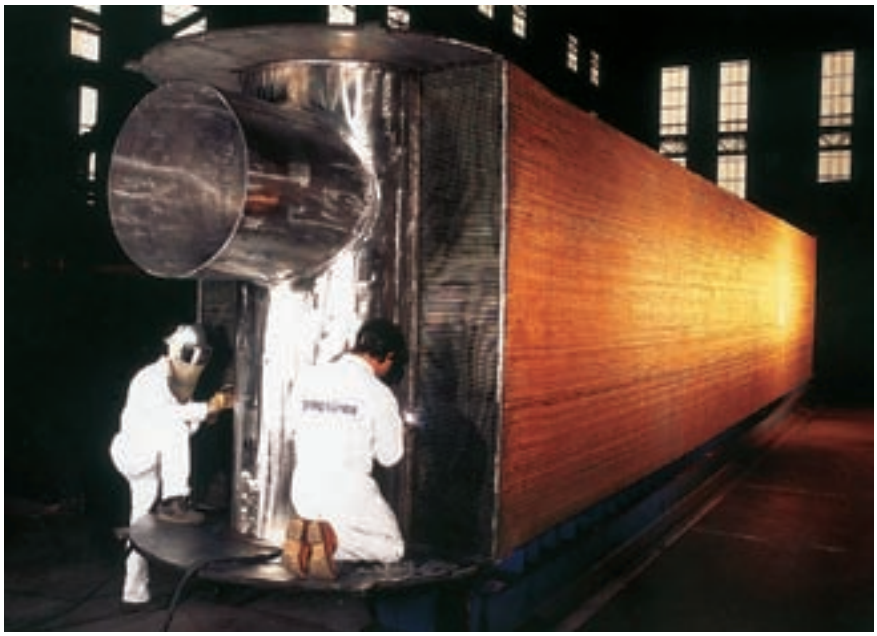
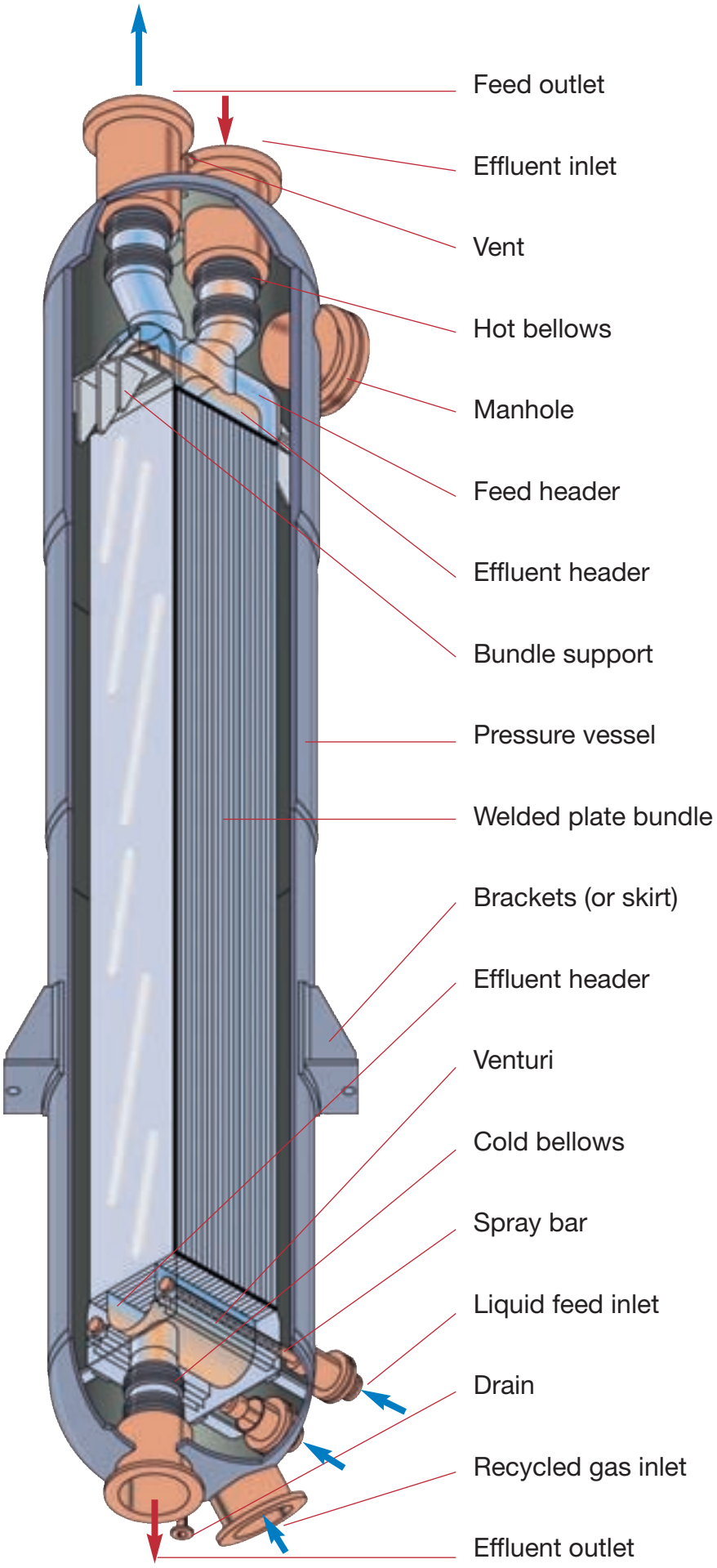


Photo : R. Quatrain/Framatome

Welding of the effluent header to the plate bundle


Feed outlet
Effluent inlet
Vent
Hot bellows
Manhole
Feed header
Effluent header
Bundle support
Pressure vessel
Welded plate bundle
Brackets (or skirt)
Effluent header
Venturi
Cold bellows
Spray bar
Liquid feed inlet
Drain
Recycled gas inlet
Effluent outlet

Technology for other applications

This section presents alternative mechanical designs that have been successfully applied in specific processes.

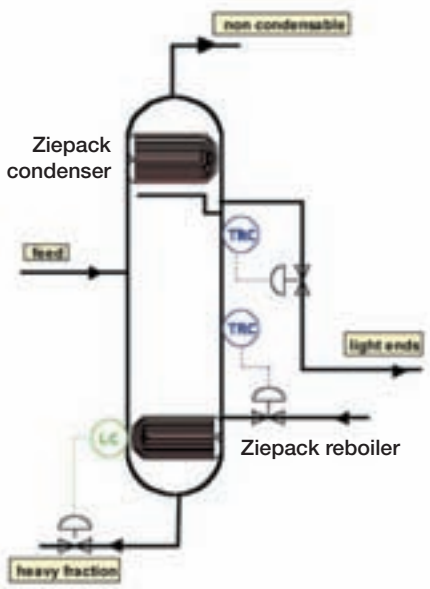
The fundamentals of Alfa Laval Packinox heat exchangers (materials, surface area, thermal and hydraulic efficiency, pressure constraints, dimensions, etc.) remain unchanged, but the designs are adapted to process conditions in the interest of providing the best technical and cost-effective solution.

Ziepack heat exchangers
Ziepack compact in-column condensers, stab-in reboilers and gas-gas heat exchangers are designed for high condensation or evaporation duty primarily in the petrochemicals industry.

The construction of Ziepack plate bundles combines plate and welding technology with “hydroforming”, the use of high pressure water to shape plates. “Double-plate channels” for the process cooling or heating medium are hydroformed between the welds of two laser-welded stainless steel plates.

Process fluid boils or condenses in “interplate channels”, i.e. the passages between two sets of double-plate channels.

Their unique design makes Ziepack heat exchangers ideal where low pressure drop and compactness are essential, particularly in vacuum distillation columns. For revamps, Ziepack presents the added advantages of fitting available column space and accommodating existing equipment.



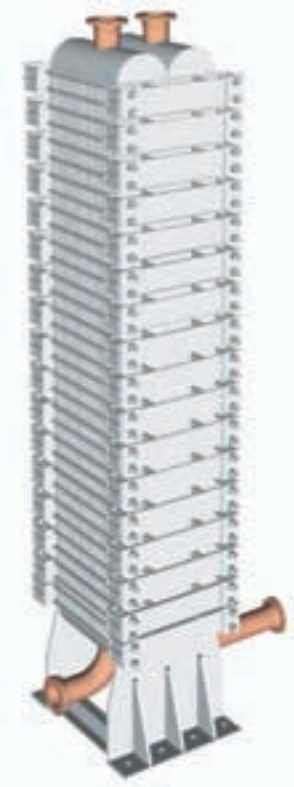
Ziepack In-column condenser fo Phenol service

Bundle & thick plate design
When design temperature, pressure and fluid properties allow safe operation without a pressure vessel, the bundle can be compressed with thick plates and tie rods like a conventional plate and frame heat exchanger.

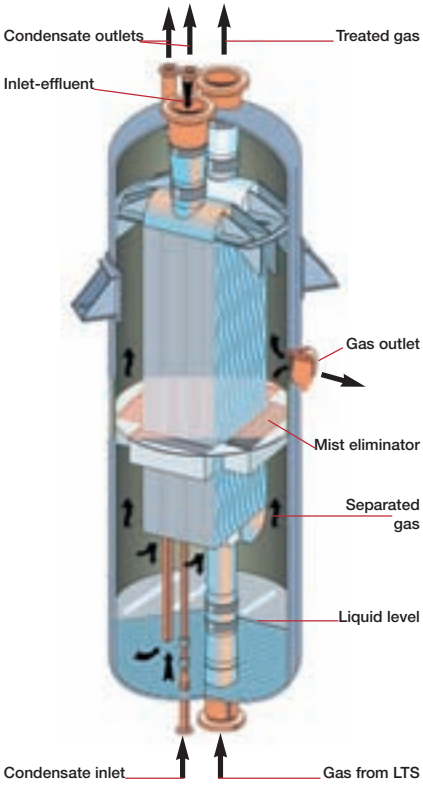
Alfa Laval Packinox Stripper Bottoms Heat Exchangers for hydrodesulfurization and Alfa Laval Packinox Reactor Effluent Chillers are manufactured according to this principle.

ProserPack
ProserPack integrates a gas-liquid separator and a large-scale compact Alfa Laval Packinox welded plate heat exchanger into a single pressure vessel for service in gas processing units.

This combined separator / Alfa Laval Packinox heat exchanger can serve in various gas processing schemes (turbo expander, mechanical refrigeration or Joule-Thompson loops), and are particularly attractive solutions for offshore platforms, where footprint and weight are crucial.



Stripper Bottoms Heat Exchanger



ProserPack for gas processing

Alfa Laval Packinox Locations

Alfa Laval Packinox' S.A.S. Offices
Alfa Laval Packinox applies a systematic policy of understanding market needs and maintaining good communications with its clients. This objective is achieved with the participation of its satellite offices, Packinox Inc. in the USA, the Moscow and Beijing business offices.

Headquarters:
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14 rue de Bassano
75116 Paris – France
Phone: (Country code 33) (1) 53 67 41 41
Fax: (Country code 33) (1) 53 67 41 42
E-mail: contact@packinox.com
General Management and Sales.

Manufacturing Center:
Alfa Laval Packinox
4 Rue Thomas Dumorey, B.P. 187
71105 Chalon-sur-Saône Cedex - France Phone: (Country code 33) (3) 85 90 35 70
Fax: (Country code 33) (3) 85 90 35 99
E-mail: contact@packinox.com
General Management, Engineering, Project Management, Production, Procurement, Inspection, Quality Assurance, Technical Division, Packinox Services and Accounting.

Subsidiary:
Alfa Laval Packinox located in Alfa Laval office
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Houston, TX 77041, USA
Phone: (Country code 1) (713) 934 3160
E-mail: francois.reverdy@alfalaval.com
Sales in North and South America.

Sales Offices:
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ul. Kalanchevskaya, d. 11, str. 2, room 313
107078 Moscow, Russia.
Tel.: (Country code 7) (495) 631 56 78
Fax/tel.: (Country code 7) (495) 631 56 77
E-mail: elena.gracheva@alfalaval.com
A liaison office for sales in the Community of Independent States (Former Soviet Union).

Alfa Laval Packinox - Beijing
Room 709, 7th Floor - Lido Office Tower
Lido, Place – Jichang Road, Jiangtai Road
Beijing 100004 – China
Phone: (Country code 86) 10-6430 1088
Fax: (Country code 86) 10-6430 1089
E-mail: jim.tao@alfalaval.com
A liaison office for sales in China.

Alfa Laval Packinox Engineering and Technical Services

Research and Development
Recognizing the necessity to maintain its technical skill at the highest level for its clients benefit, Alfa Laval Packinox continues to devote significant resources to Research and Development, developing and expanding the future applications of Alfa Laval Packinox technology. In addition Alfa Laval Packinox can utilise the Framatome Technical Center and its specialists in various technical fields for its research programs.

Engineering Staff
Alfa Laval Packinox's Engineering Division offers combined expertise in both thermal / hydraulic and mechanical engineering.
- 6 Thermal Engineers
- 4 Mechanical Engineers
- Draftsmen

Engineering Equipment
The 350 m^2 Alfa Laval Packinox facilities include:
- In-house PASHA thermal and hydraulic design and rating computer software. This sophisticated two phase flow computer code has been verified by laboratory tests and full scale Alfa Laval Packinox heat exchanger test runs
- STAR CD computer flow dynamic calculation code
- SYSTUS, a finite elements computer code
- Pro/ENGINEER CAD system
- Pro/MECHANICA mechanical analysis software
- 8 CAD workstations
- Plotters and laser printers
- Electronic data transmission modem connected to Compuserve/Internet Possibility of recording plans on CD-ROM
- MICROPROTOL pressure vessel design software
- In-house mechanical design software

Project Management
Each project, upon receipt of the order, is assigned a Project Manager. The Project Manager is responsible for coordinating all tasks from design of the heat exchanger to its completion, including testing and shipping. Throughout the project, the Project Manager communicates continuously with the client and with the main subcontractor. He is also responsible for meeting delivery deadlines. The Project Management Team consists of three Project Managers based at the fabrication facility in Chalon-sur-Saône.

Alfa Laval Packinox Services
Alfa Laval Packinox Services provides training, diagnostic, technical expertise and assistance. It also supplies spare parts when required. Three field engineers and two technicians have full time responsibility for this assistance.
Codes and Standards Packinox refers to the following codes and standards. It also complies with the local regulations of the countries to which Alfa Laval Packinox products are delivered. This list is indicative only.
- Australia: AS 12 10 standard
- Europe: EN European Standards
- France: CODAP
- Germany- AD Merkblatter
- Great Britain: PED 5500
- India: IS 2825 - IS 875 - IS 1893
- Italy- RACCOLTA VSR-M-S
- Japan: High Pressure Gas Control Law
- Russia: Gosgortekhnadzor GOST 14 249, 24 755, 25 859, R 51273, R 51274, OST 26-291, 36-75, PD PTM 26-15, SNIP II.11, OTY-1
- United States:
  - ASME Boiler and Pressure Vessel Code: section VIII Division 1 and Division 2 for Construction of Pressure Vessels section II for Material Specifications and Properties section V for Non Destructive Examinations section IX for Welding and Brazing Qualifications
  - ASME B 16.47 for Large Diameter Steel Flanges
  - ASME/ANSI B 16.5 Pipe Flanges and Flanged Fittings
  - ASME B 31.3 for Process Piping
  - ASCE Minimum Design Loads for Buildings and Other Structures
  - ICC International Building Code
  - API 938 and 941 standards
  - ASTM Standard
  - EJMA Standard for Expansion Joints
  - NBIC for Repairs on Location
  - Welding Research Council Bulletin 107 and 297

Association Membership
Alfa Laval Packinox is a member of
- National Petroleum Refiners Association (NPRA)
- Groupement de Recherche sur les Equipements Thermiques (GRETh) in France
- Heat Transfer Research Institute (HTRI) in the USA

Alfa Laval Packinox Fabrication Facilities

Explosion forming of plates and plate bundle assembly are carried out at Alfa Laval Packinox's purpose-built facilities at Chalon-sur-Saône in Burgundy, France.

Tens of thousand of stainless steel plates up to 2m wide, in lengths reaching 15m, have been explosion formed underwater since Alfa Laval Packinox first developed this technology.

The plates' distinctive chevron-shaped corrugations make Alfa Laval Packinox heat exchangers highly efficient static mixers, providing optimum heat transfer for two-phase flow.

The hundreds of plates used to build a single Alfa Laval Packinox are prepared for welding. Inlet/outlet inserts are added to ensure low pressure drop by distributing fluids over minimum space during operation.

Photo: Jean-Pierre Salomon/Framatome

A newly corrugated plate emerging from the explosion forming pool

The plates are then stacked on the world's largest bundle welding press where automated TIG welds are performed.

Operators manually weld header boxes to the bundle.

All materials and processes used in the fabrication of Alfa Laval Packinox heat exchangers must meet rigorous quality requirements. Thorough inspection is performed at each step of fabrication.

After passing a series of inspections, the plate bundle is inserted into a pressure vessel. Additional checks are carried out, and the heat exchanger is prepared for transport.

Manufacturing processes are managed by the Production, Engineering and Design Departments and supported by a specialized Quality Control, Inspection and Assurance system. Alfa Laval Packinox holds certificates demonstrating conformity with ISO 9000, ASME, National Board and other major standards.

Photo: René Quatrain/Framatome

Inside the world's largest bundle press, an operator checks the welding of the bundle wall

Forming Facility
The forming facility comprises:

- Two 30m x 30m halls for explosion forming preparation
  - Two lines of handling equipment specially designed to handle corrugated plates
  - Two 10 T electrical trolleys

- One 20m diameter explosion forming pool
  - One 2 x 12,5 T travelling crane
  - Low chloride content water control unit
  - Waste water treatment facility
  - 15m plate capacity

- One storage bunker for explosives

- Utilities
  - Electrical Power 380 V - 160 kVA
  - Compressed air
  - Low chloride content water

Photo: René Quatrain / Framatome

Insertion of the plate bundle into the pressure vessel is closely monitored

Assembly Shop
The 180m x 25m x 25m assembly shop houses:

• Overhead cranes:
- Two 120 T travelling cranes (height under hook: 19m)
- One 60 T travelling crane
- Five lines of handling equipment specially designed to handle corrugated plates

• Assembly equipment
- Two tables for plate edge preparation
- Two 280 T welding presses
- One 750 T welding presses

• Welding
- Four automatic TIG/PLASMA welding machines each equipped with two or four driven robot heads
- Six semi-automatic MIG welding machines
- 31 sets of TIG manual welding machines

The 70m x 20m x 12m extension houses:

• Overhead cranes
3.16 T Travelling cranes

• Cutting equipment
- One computer controlled plasma cutting machine equipped with two heads on a 2m x 15m table

• Inspection
- One specific table which allow inspection of both sides of each sheet

Utilities
- Electrical power 380 V 1600 kW
- Compressed air
- Low chloride content water

Quality control
At all stages of manufacturing, equipment parts are inspected in order to ensure quality and compliance with specification. Inspection includes:
• Non destructive examination
- X-Ray Radiography
- Ultrasonic
- Magnetic Particle
- Dye penetrant
- PMI
- Hydrostatic test using demineralized water with less than 5 pprn chloride content
- Pneumatic pressure and vacuum tests
- All examination and testing equipment is calibrated periodically at pre-established intervals.

Packinox inspectors utilize Framatome's Destructive Test Laboratory for Charpy, tensile, macrograph and micrograph testing.

Photo: Jean-Pierre Salomon / Framatome

Welding of the effluent header to the plate bundle

Alfa Laval Packinox Subcontractors

Alfa Laval Packinox S.A.S. works with reputable subcontractors and has the appropriate organization to ensure that subcontractors comply with Alfa Laval Packinox standards and specifications.

Pressure Vessel Manufacturers
Alfa Laval Packinox has worked with the following pressure vessel manufacturers:

• In France:
- C.D.R. Chaudronnerie des Roches, Saint-Clair-du-Rhône,
- C.M.P. Arles,
- Sotralentz Metal Industrie, Drulingen,
- Franc-Comtoise Industrie, Lons-le-Saunier.

• International:
- Chiyoda Protech, Kawasaki, Japan,
- M.H.I., Hiroshima, Japan,
- Doosan, Hangwon-City Kyung-Nam, Korea,
- Schwartz-Hautmont, Tarragona, Spain,
- Cosmin Spa, Cagliari (Sardegnia), Italy,
- Hanover, Houston (Texas), United States,
- ATB, Brescia, Italy,
- W.E. SMITH, Australia.

Cr-Mo Low Alloy Steel Plate Suppliers
The following companies have supplied Alfa Laval Packinox's pressure vessel manufacturers.
As Alfa Laval Packinox works with various pressure vessel manufacturers in different countries, this list is not comprehensive.

- CLI/Fafer, Le Creusot, France,
- Voest Alpine, Strasbourg, France,
- Dillinger Hutte A.G., Dillingen Saar, Germany

Cr-Mo Low Alloy Steel Forging Suppliers
The following companies have supplied Alfa LAval Packinox's pressure vessel manufacturers. As Alfa Laval Packinox works with varions pressure vessel manufacturers in different countries, this list is not comprehensive.

- Loire Industrie, Saint-Chamond, France,
- Bruck, Ensheim, Germany,
- Mame Cividate Camuno (BS), Italy.

Stainless Steel Plate Suppliers

• In France:
- Ugine & Alz, Puteaux
- Outokumpu, Saint-Quentin Fallavier

Welding Material Suppliers

• In France:
- Böhler-Thyssen, Maurepas
- Oerlikon, Saint-Ouen l'Aumône

Bellows Suppliers

- SFZ, Chassière, France
- Techniflex Witzenmann France Sarl, Marne-la-Vallée, France
- Pathway, Oak Ridge, TN, USA

Alfa Laval Packinox Certifications

ISO 9001 Certification
Alfa Laval Packinox's objective is to produce heat exchangers with the highest quality standards.

Quality Assurance programs which support that objective have been operating for many years.

Since June 1994, Alfa Laval Packinox's Quality Assurance programs have been certified as meeting the full requirements of
ISO 9001 for design, fabrication, inspection and technical assistance. This certification being regularly renewed.

Alfa Laval Packinox's Quality Assurance programs aim to guarantee that the equipment manufactured conforms in every respect to its design requirements and is built according to normal engineering standards and good practices.

ISO 14001
Since June 2002, Alfa Laval Packinox's environment Management system is certified ISO 14001.

ASME Certification
Since September 1992, Alfa Laval Packinox has held the following ASME Certificates:

- U Certificate of Authorization N° 26, 571
- U2 Certificate of Authorization N° 26, 572

National Board of Boiler and Pressure Vessel Inspectors Certification
Since October 1992, Alfa Laval Packinox has held an R Certificate of Authorization N° R 3002 covering repair and alteration.
Packinox is also authorized to apply the NB mark.

Gosgortekhnadzor Authorization
In March 1995, Alfa Laval Packinox received Gosgortekhnadzor accreditation allowing the importation and use of Alfa Laval Packinox exchangers in Russia and the authorization to perform repairs if required.

Alfa Laval in brief

Alfa Laval is a leading global provider of specialized products and engineered solutions. Our equipment, systems and services are dedicated to helping customers to optimize the performance of their processes. Time and time again.

We help our customers to heat, cool, separate and transport products such as oil, water, chemicals, beverages, foodstuffs, starch and pharmaceuticals.

Our worldwide organization works closely with customers in almost 100 countries to help them stay ahead.

How to contact Alfa Laval

Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com

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