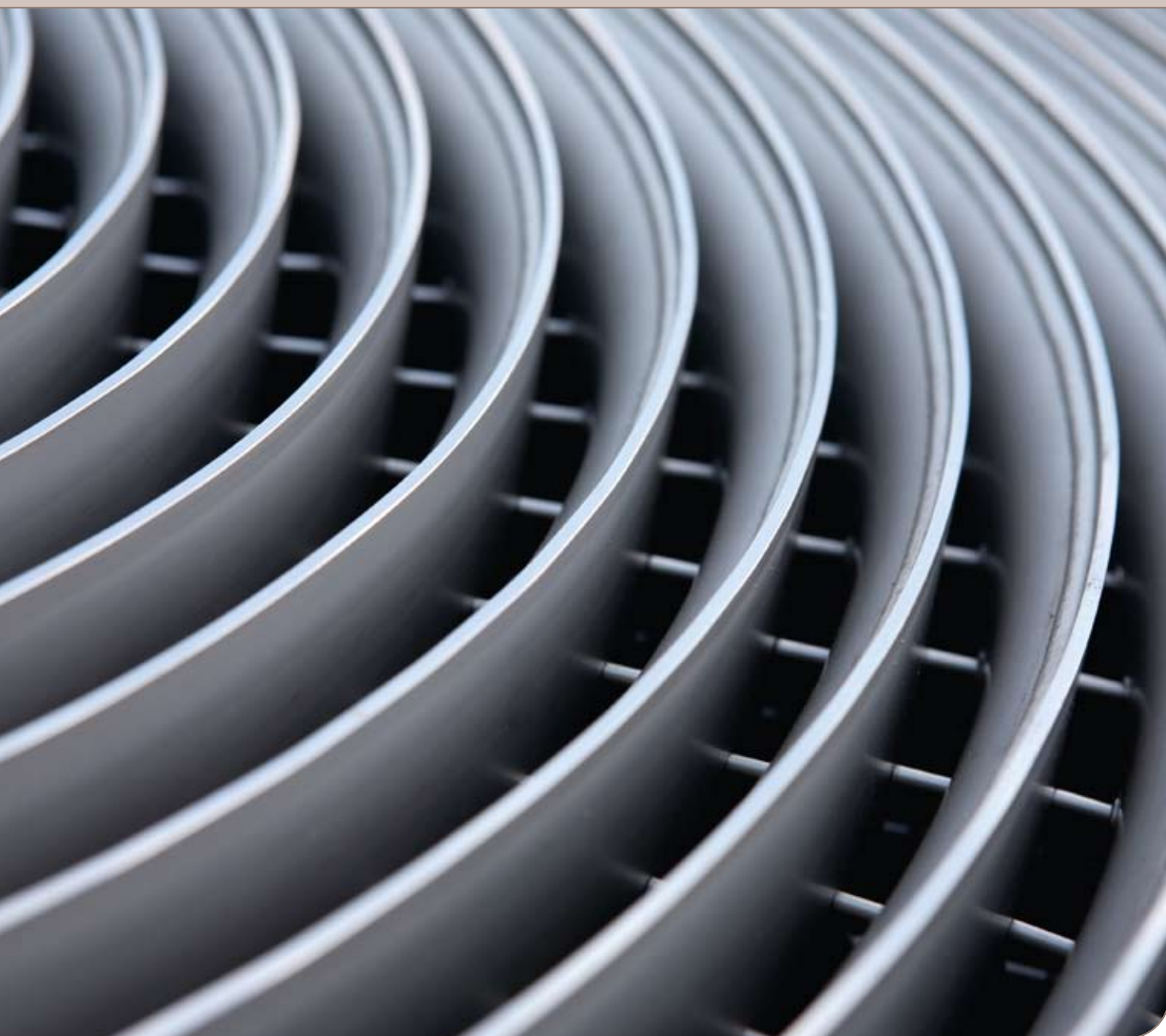




## Alfa Laval spiral heat exchangers

Problem solvers for tough applications



- Reliable operation, virtually no fouling and clogging
- Huge savings on maintenance costs
- Energy and fuel savings
- Short payback times

# Heat exchanger downtime getting you down?

Does your process involve fouling fluids, sludges, emulsions, slurries, fibres or particle loaded liquids? Do your shell-and-tube heat exchangers suffer from fouling and clogging, resulting in costly downtime and huge maintenance bills that keep you awake at night?

If so, the fouling and clogging probably also lead to other costs, such as higher fuel consumption in the boiler and increased electricity consumption for pumping power.

## **We have the solution**

Already installed in industrial plants worldwide for liquid-to-liquid and two-phase duties, Alfa Laval spiral heat exchangers (SHEs), are real tough problem solvers that do not suffer from fouling and clogging – in fact, they almost never break down. As a result, maintenance costs are impressively low.

## **Can you rely on an SHE?**

Yes, you can! Once you have experienced the reliability of an SHE, you will never look back. Alfa Laval SHEs are well-proven, robust, welded heat exchangers with surprisingly low maintenance requirements – they will give you complete peace of mind.

Invest in an Alfa Laval SHE and you invest in world-class quality. We have produced more than 30,000 units for a wide variety of industries and customers all over the world. Many plants in your industry are already enjoying the financial benefits.

## **Savings beyond belief**

With an SHE, intervals between cleaning are long due to a powerful self-cleaning effect. Depending on the application, an SHE can run for several years without opening, while in the same application an shell-and-tube would experience

severe fouling. When it's finally time for maintenance SHEs are considerably easier than shell-and-tubes to open and clean. The bottom line is substantial savings in terms of reducing downtime.

## **Energy savings due to waste heat recovery**

Since Alfa Laval SHEs recover waste heat from your process, they offer substantially higher energy savings with lower capital expenditure than shell-and-tube heat exchangers. The thermal efficiency of an SHE is two to three times higher than that of a comparable shell-and-tube unit. Valuable energy can be recycled for a wide range of uses, which benefits your bottom line.

Another energy saving feature...an SHE will only use a portion of the pumping energy required by an shell-and-tube.



## Emissions eliminated, energy savings

Avdeevskiy coke processing works, Ukraine, replaced two open final gas cooling systems, using scrubbers, with Alfa Laval closed systems utilizing spiral heat exchanger columns. Harmful emissions were eliminated. Reduced pumping requirement and elimination of water treatment provided substantial energy savings.



### Lower fuel costs, reduced emissions

The heat recovery capability of our SHEs also means you will consume less fossil fuel in your steam boiler. Reduced consumption of fossil fuel, in turn, reduces your plant's emissions of greenhouse gases to the atmosphere.

### Installation and material costs are lower as well

An SHE normally needs only a fraction of the floorspace required by a shell-and-tube unit for installation and service access, and less pipework and steel structures are needed. The result is substantially lower installation costs compared with shell-and-tube.

Also, in many cases, there are considerable reductions in material, since one SHE can replace two or three shell-and-tubes installed in series.

Another important consideration is the impact on the environment. When the SHE finally reaches the end of its working life, which could be 30 years or more, it is 99% recyclable.

### Short payback times

Imagine, with an SHE installed, in many applications, you can run your process without unexpected shutdowns for months or years, while with shell-and-tube units cleaning often needs to be done much more frequently. This impressive reduction in maintenance costs minimizes the payback time for your investments.

Whether it's a new process or a revamping project, where the goals are to optimize the process, save energy and reduce emissions, you can't go wrong with Alfa Laval SHEs.

### Benefits of Alfa Laval SHEs

- Virtually no fouling or clogging
- Reliable operation, maximum uptime
- Easy to open and clean, low maintenance costs
- Low installation costs, less pipework and steel structures
- Energy savings due to high heat recovery
- Lower consumption of fossil fuel
- Reduced greenhouse gas emissions
- Short payback times

### Industries where an SHE can be used:

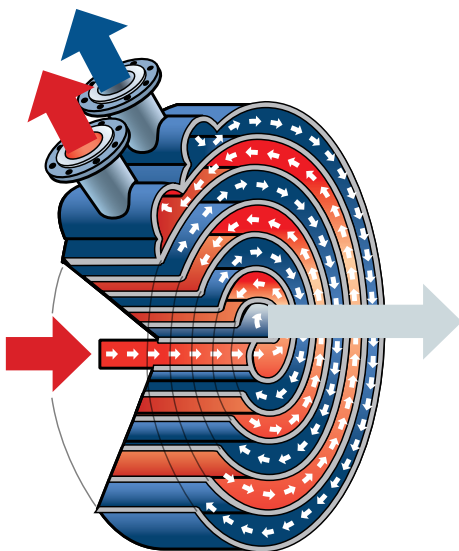
- Petrochemical
- Refinery
- Steel making
- Pulp and paper
- Mineral processing (metals, ore)
- Wastewater treatment (municipal and industrial)
- Pharmaceutical
- Vegetable oil refining
- Natural gas transportation

- Self-cleaning design
- High thermal efficiency
- Waste heat recovery
- No dead spots or stagnation



# The heat exchanger that cleans itself

Alfa Laval spiral heat exchangers (SHEs) are based on an ingenious design. It provides optimum heat transfer and flow conditions for a wide variety of fluids, with a built-in self-cleaning effect, while keeping the overall size of the unit to a minimum.



Above: Welded single-channel geometry eliminates the risk of intermixing of the two fluids.

Right: The secret behind the self-cleaning effect that makes SHEs the ideal choice for fouling duties. If fouling starts to occur, the cross-section of the channel is decreased. Yet, since the entire flow must still pass through it, the velocity here increases, causing a scrubbing effect that flushes away any deposits.

## An SHE works like this...

Alfa Laval SHEs are circular units containing two concentric spiral flow channels, one for each fluid. The different media flow counter-currently in these channels with no risk of intermixing.

One fluid enters the centre of the unit and flows towards the periphery. The other fluid enters the unit at the periphery and moves towards the centre. The channels are curved and have a uniform cross section.

The product channel is normally open on one side and closed on the other. The heating/cooling medium channel can sometimes be closed on both sides, depending on the cleanliness of the heating/cooling medium. Each channel has one connection in the centre and one on the periphery of the heat exchanger.

## Why are SHEs the best possible choice for fouling applications?

In shell-and-tube heat exchangers the flow enters different tubes in parallel. When tubes start to foul, the local

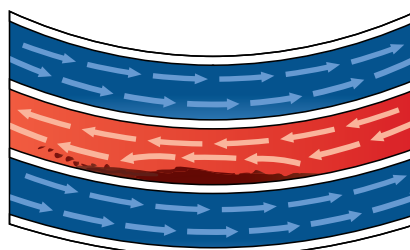
pressure drop increases pushing the fluid to find alternative flow paths. The result is that fouling and clogging of the tubes happens very quickly.

This is not the case with SHEs! The design of an SHE is particularly suitable for use with fluids that tend to cause fouling. Its single channel geometry and turbulence, with resulting high shear stress, dramatically reduce fouling and make SHEs to a large extent "self-cleaning".

## Scrubbing and scouring effects

If fouling starts to occur in the heat transfer channel of an SHE, the cross-section of this part of the channel is decreased. Yet, since the entire flow must still pass through it, the local velocity here increases, causing a scrubbing effect that flushes away any accumulations of deposits as they form.

Another important anti-fouling factor is the flow turbulence. This is caused by both the spiral flow and the continuously curving passages, which create turbulence in the flow.



- Cross-section decrease
- Local velocity increase
- Deposits removal

**Fouling minimized, maintenance costs reduced**  
In its new refinery, a Russian oil company replaced 12 shell-and-tube heat exchangers in the visbreaking process with eight Alfa Laval SHEs. Since there is hardly any fouling, the company saves €1.6 m Euro per year on maintenance and production is more stable and profitable.



### Waste heat recovery

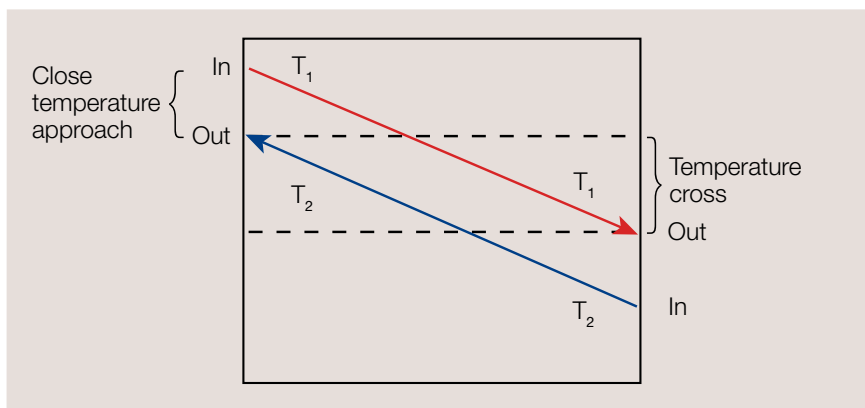
The secret is the true counter-current flow. It enables crossing temperature situations where the cold fluid can be heated to temperatures very close to those of the hot fluid.

The closer the temperature approach between two fluids, the more heat is recovered. This effect is enhanced by the high turbulence in the unit due to the single channel geometry and the arrangement of the studs.

### Dead spots eliminated

The single-channel geometry and stud arrangement offer other important benefits as well. The fluid is fully turbulent at a much lower velocity than in straight tube heat exchangers, and

**True counter-current flow, heat recovery possible!**



each fluid travels at constant velocity throughout the whole unit. This eliminates the risk of dead spots and stagnation.

### Easy-to-clean heat transfer solution for Danish biogas plant



In 1992 Lemvig Biogas, Denmark, installed four Alfa Laval SHEs to recover heat from digested manure flows. The SHEs are STS-type units (sludge-to-sludge), designed for heat recovery by using sludge on both sides.

Major process challenges are sand and plastic remnants in the organic waste flows, and potential build-up of magnesium ammonium phosphate, known as struvite.

The SHEs are easy to open for visual inspection and cleaning is simple and inexpensive. According to

Maintenance Manager Dan Grummesgaard, there are hardly ever problems. "The struvite build-ups usually occur in the ancillary equipment. The heat exchanger channels still look as good as new after years of hard use and acid cleaning."

Two of the SHEs were replaced in 2003 and 2005, having withstood about 11 years of 24/7 running, and chemical cleaning with inhibited hydrochloric acid. In 2010, two units were replaced by larger Alfa Laval SHEs to provide a 45% increase in capacity.

# Designed to meet all your application needs

Available with design pressures of up to 100 barg, Alfa Laval SHEs are designed to meet all your application needs, from dirty fluids to vacuum condensation and reboiling duties. Although Alfa Laval offers standardized versions, many customers request the customized solutions of our SHEs shown on these pages.

Spiral Heat Exchanger Type 1	Spiral Heat Exchanger Type 2
	
<p>Maximum heat recovery with counter-current flow</p>	<p>Cross-flow condensing with lowest possible pressure drop</p>
<p>The Type 1 is a good choice when one, or both, fluids are fouling, due to its self-cleaning effect. Since the fluid flows continuously in one single channel the force of the fluid acts against any deposits, “pushing” them through the channel and out the other end. In a few cases Type 1 can be used as a condenser, for example when the cooling media is heavily fouling, or very close temperature approach is required (since the counter-current configuration is thermally the most efficient).</p> <p>The compact nature of the Type 1 spiral often allows several large shell-and-tubes units to be replaced by one single SHE, giving considerable infrastructure benefits in addition to the reduction in maintenance and cleaning activities. If, or when, the SHE needs cleaning, the covers can easily be removed and the SHE cleaned in-situ using a hydrojet.</p> <p><b>Benefits</b></p> <ul style="list-style-type: none"> <li>• Virtually no fouling and clogging</li> <li>• Reliable operation, maximum uptime</li> <li>• Easy to open and clean, low maintenance costs</li> <li>• Energy savings due to high heat recovery</li> <li>• Compactness.</li> </ul> <p><b>Applications</b></p> <ul style="list-style-type: none"> <li>• Fouling liquids: containing solids, fibres, liquors, slurries and sludges.</li> <li>• Liquid/liquid: Preheating, heating, cooling, interchanging, heat recovery.</li> </ul>	<p>The Type 2 SHE is used for 2-phase duties, both condensing and evaporation (re-boiling). In this configuration the spiral is always in the vertical position. The compactness of the SHE and the fact that it is mounted vertically allows it to be installed with a very small footprint compared to the equivalent shell-and-tube unit and reduces supporting structures and piping complexity.</p> <p>The Type 2 SHE has cross-flow rather than counter-current flow. Because of the good channel gap on the condensing side there is generally a very low pressure drop on the condensing circuit, therefore it is ideally suited to vacuum condensation duties. There are many different configurations of Type 2, the two most common are shown on page 8.</p> <p><b>Benefits</b></p> <ul style="list-style-type: none"> <li>• Low pressure drop is ideal for vacuum condensation</li> <li>• Reliable operation, maximum uptime</li> <li>• Low maintenance costs</li> <li>• Compact and easy to install.</li> </ul> <p><b>Applications</b></p> <ul style="list-style-type: none"> <li>• Gases: pure vapour and mixtures with inert gases.</li> <li>• Vapour/liquid: Top condensers, reflux condensers, vacuum condensers, vent condensers, reboilers with fouling fluids, gas coolers.</li> </ul>

In our four main types, the shape and size of the spiral channels can be further customized to form a perfect match for the demands associated with a wide range of process fluids, thermal duties and industrial applications.

Spiral Heat Exchanger Type 3	Spiral Heat Exchanger Type 4
	
Two in one – cross-flow and counter-current paths in the same unit	Column solutions
<p>The Type 3 SHE is often called a “steam heater” and has a mixture of Type 1 and Type 2 features. The main feature is that the liquid being heated by the steam is generally fouling, therefore the circuit is designed to be accessible for cleaning, which is not the case with the normal Type 2. In addition the counter-current nature of the Type 3 allows tighter temperature approaches than are achievable with the cross-flow nature of the Type 2.</p> <p><b>Benefits</b></p> <ul style="list-style-type: none"> <li>• Virtually no fouling and clogging</li> <li>• Reliable operation, maximum uptime</li> <li>• Easy to open and clean, low maintenance costs</li> <li>• Energy savings due to high heat recovery.</li> </ul> <p><b>Applications</b></p> <ul style="list-style-type: none"> <li>• Fouling liquids: containing solids, fibres, liquors, slurries and sludges requiring heating by steam.</li> </ul>	<p>The Type 4 is an SHE integrated into a column, often as part of a distillation process. In most cases the spiral operates similarly to the Type 2 version, where the operation is in cross-flow and the open channel allows extremely low pressure drop in vacuum situations. Another extremely important feature and benefit is that the two fluids are never in physical contact so there is no cross-contamination, which often happens in traditional columns.</p> <p>The SHE is always mounted vertically and the diameter of the spiral is the same as the diameter of the column in cases where several spirals are stacked in series. The efficiency of the SHE allows the column to be both shorter in height and smaller in diameter than traditional solutions, thus offering major savings in infrastructure and installation costs.</p> <p><b>Benefits</b></p> <ul style="list-style-type: none"> <li>• No contact between fluids means no contamination</li> <li>• Reliable operation, maximum uptime</li> <li>• Energy savings due to high heat recovery</li> <li>• Significant height and weight savings.</li> </ul> <p><b>Applications</b></p> <ul style="list-style-type: none"> <li>• Vapour/liquid: Top condensers, reflux condensers, vacuum condensers, vent condensers.</li> </ul>

# A look inside the products

## Spiral Heat Exchanger Type 1

Maximum heat recovery with counter-current flow

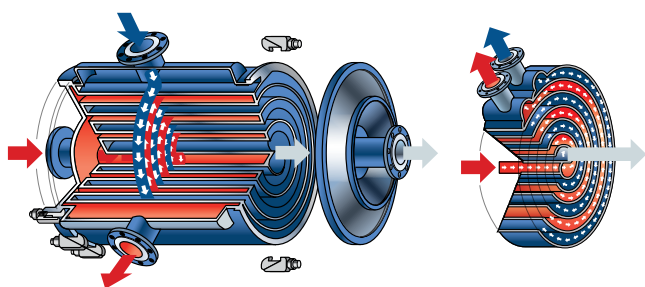
The Type 1 is almost always a liquid/liquid heat exchanger. In most cases it is mounted horizontally and can be opened at each end. Each channel circuit is seal welded on one side and open on the other. The open channel is sealed by the gasket face of the end cover. The fluid in the two channels always follows the spiral direction, from the outside towards the centre, or the centre to the outside. The flow arrangement is counter-current.

The unit is preferably mounted horizontally. In the vertical position there is a risk of solid material settling by gravity to the bottom of the channel. Also, for cleaning it needs to be rotated to the horizontal position.

### Performance data

Temperature: -100°C to 400°C  
Design pressure: Full vacuum to 100 barg  
Diff. pressure: Up to 50 barg  
Heat transfer area (max): 2,500 sqm

Horizontal configuration



## Spiral Heat Exchanger Type 2

Cross-flow condensing with lowest possible pressure drop

The Type 2 spiral is used for 2-phase duties, both condensing and evaporation (re-boiling). In this configuration the spiral is always in the vertical position.

The channel with the fluid being condensed or evaporated is usually open at each end so, unlike in Type 1, the fluid flows across the spiral rather than following the spiral. The liquid on the other circuit, whether heating or cooling, flows along the spiral similar to the Type 1 and this channel is seal welded at each end. Thus, the fluid is completely enclosed and the channel is not accessible for cleaning (therefore the liquid must be clean).

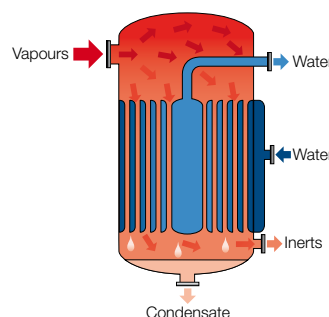
The Type 2 spiral is always cross-flow rather than counter-current flow. This means that it is thermally less efficient than the Type 1. Generally there is a very low pressure drop on the condensing circuit so it is very well suited to vacuum condensation duties. There are many different configurations of Type 2, the two most simple and common are as shown.

On the two-phase circuit there is an open area at the inlet/outlet to allow for good distribution across the diameter of the spiral since the fluid or vapour is in cross flow.

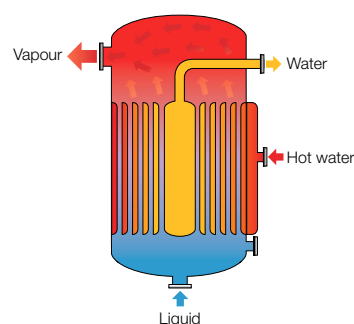
### Performance data

Temperature: -100°C to 400°C  
Design pressure: Full vacuum to 100 barg  
Diff. pressure: Up to 80 barg  
Heat transfer area (max): 2,500 sqm

Condenser



Evaporator/re-boiler



## Spiral Heat Exchanger Type 3

Two-in-one – cross-flow and counter-current paths in the same unit

The Type 3 spiral is often called a “steam heater” and has a mixture of Type 1 and Type 2 features. It can be horizontal or vertical. The main feature is that the liquid being heated by the steam is generally fouling which means that the circuit must be accessible for cleaning.

Therefore the liquid circuit is sealed at one side by welding and at the other end by the gasket face of the end cover (same as for Type 1). The vapour circuit however is more similar to the Type 2, operating in cross-flow rather than spiral flow, and the circuit is sealed by welding along one side. This construction is not so common, most 2-phase applications use the regular type 2.

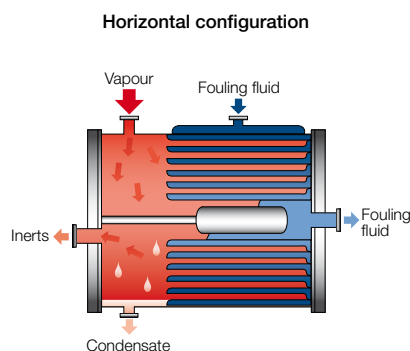
### Performance data

Temperature: -100°C to 400°C

Design pressure: Full vacuum to 100 barg

Diff. pressure: Up to 50 barg

Heat transfer area (max): 2,500 sqm



## Spiral Heat Exchanger Type 4

Column solutions

The Type 4 spiral refers to a spiral that is integrated into a column, often as part of a distillation process. In most cases the spiral operates similarly to the Type 2.

The spiral is always mounted vertically and the diameter of the spiral is the same as the diameter of the column in cases where several spirals are stacked in series.

In cases where there is a single spiral condenser mounted on the top of the column, the bottom connection (vapour in) is the full diameter of the spiral but can be less than the diameter of the column it sits on. In terms of operation the spiral can be a simple reflux type condenser or have condensate collection. Inert gases are extracted separately.

The main Type 4 configurations are shown below.

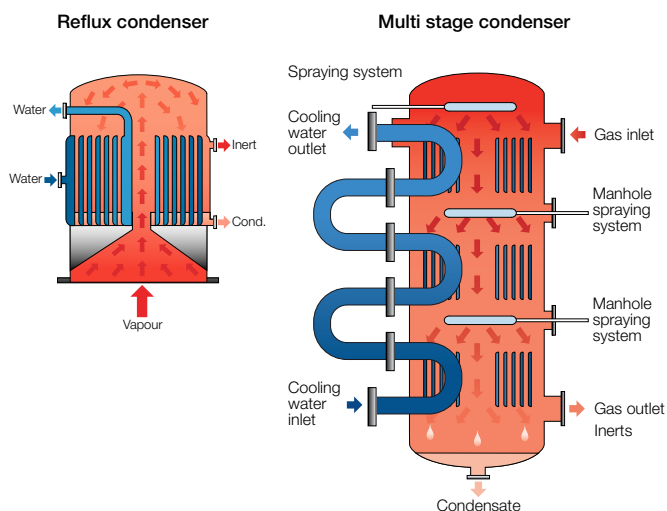
### Performance data

Temperature: -100°C to 400°C

Design pressure: Full vacuum to 100 barg

Diff. pressure: Up to 80 barg

Heat transfer area (max): 2,500 sqm



- Alfa Laval – the heat transfer specialists
- Continuous product development
- State-of-the-art design and testing
- Advanced calculation tools



## Customer-driven product development

The technology leader in the field of heat transfer, Alfa Laval has manufactured SHEs and continuously improved their designs for almost half-a-century. Today's compact, energy saving, non-fouling SHEs are an excellent example of the company's ongoing investments in product development.



### You talk, we listen

We work closely with our customers to help them meet process challenges. You are our best source of information and inspiration. Although we have a standard SHE range, we supply a large number of customized SHEs, engineered to meet the needs of each new installation.

### State-of-the-art design and testing

Alfa Laval SHEs are designed using the latest techniques and testing methods. Drawing on our huge reservoir of know-how and experience in the fields of thermal and mechanical engineering, our R&D and manufacturing departments continuously improve production techniques and component design.

### Standard process equipment

SHEs are now standard equipment for many processes. They play an important role in plants in a wide range of industries by eliminating heat exchanger fouling and clogging problems, saving energy and helping to reduce greenhouse gas emissions.

Whatever the duty, Alfa Laval has an extensive catalogue of references and case stories, the necessary experience, and a complete product portfolio. Our sales staff are equipped with sophisticated calculation and quotation tools, and we can recommend the best solution for your process.



Alfa Laval has manufactured SHEs and continuously improved their designs for almost half-a-century.

- Extremely high reliability
- Impressively low maintenance costs



## SHE stands for maximum uptime

### Low maintenance, easy access

Install SHEs and you will dramatically reduce your downtime and maintenance costs. In addition to the fact that they hardly ever break down, Alfa Laval SHEs require much less maintenance. Some of our customers haven't opened their SHEs for many years. Compare that with any other heat exchanger!

SHEs are very easy to open and access for cleaning. Removing the cover is more convenient than extracting a bulky tube bundle from its shell.

### Infrequent cleaning

The unique design of SHEs reduces cleaning intervals to a minimum and there is no risk of a channel becoming plugged. Hydroblasting is often all it takes to clean an SHE. No time-consuming drilling is required to open up clogged tubes. SHEs can also be cleaned using Alfa Laval's CIP (Cleaning In Place) unit with no need to even open the SHE.

### Although you probably won't need our help...

When you install an Alfa Laval SHE, you gain access to a world-class customer service organization. Alfa Laval has a

global team of highly experienced field service engineers and welding specialists to support you. There are more than 55 service centres world-wide, some specializing in welded heat exchangers. Our specialists can give you all the support and advice you need for cleaning, maintenance and operation. With Alfa Laval reconditioning support it can be possible to put an old SHE back into operation again.

### Installation and commissioning support and user training

Installation and commissioning support ensures trouble-free start-up and helps you get the most from your SHE in terms of performance and reliability. Training for operators and maintenance personnel can be included. Our instructors have hands-on experience in operating and maintaining the equipment and genuine application expertise.

*Please contact your local representative for more details.*

### Wherever you are, Alfa Laval is there

- Worldwide field service organization
- Service Centers throughout the world
- Contact Alfa Laval for advice and expert repairs when needed
- Cleaning advice
- Installation and commissioning support, and training on SHEs.



Today, Alfa Laval has three production sites providing worldwide deliveries and service to its spiral heat exchanger customers. They are situated in the United States, France and India. There are four Alfa Laval service centres specializing in spiral heat exchangers, located in Houston, USA, Nevers, France, Potok, Russia and Kunshan, China.

## 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, food-stuffs, starch and pharmaceuticals.

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

