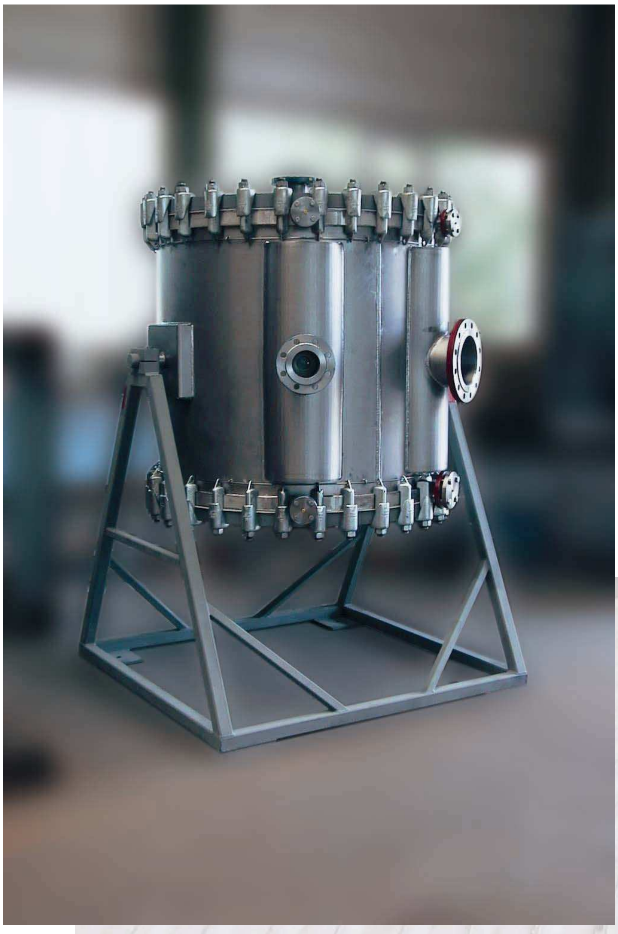
TRANTER®
HES GmbH

Instruction Manual

Spiral heat exchanger



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1 Introduction

This manual is intended as your general guide for the proper installation, operation and maintenance of your HES Spiral Heat Exchanger. We advise you to study it thoroughly and follow the instructions contained within.

The design, fabrication, operation and repair of a heat exchanger must observe the rules of the applicable pressure vessel code (abbreviated as "Code") as well as the applicable local and/or company safety and/or environmental legislation and regulations. The same applies to the use of the fluids in the heat exchanger. HES assume that the user respects these rules.

Operation, maintenance and repair should be carried out by qualified personnel only, who shall carry out their work with the appropriate care and skill.

The spiral heat exchanger must be implemented into the overall plant safety concept and must be considered in the plant's start-up, operation and shut-down procedures.

Operation, modification and repair may require approval by a Code inspector.

HES accept no responsibility or liability for damage caused by incorrect installation, operation or maintenance due to failure to observe the instructions of this manual.

The indications of the nameplate are on the general arrangement drawing supplied with the heat exchanger.

2 Description

Spiral heat exchangers belong to the family of compact heat exchangers. They are fabricated from two or four long metal strips that are wound concentrically around a centre to form two or four single-flow passages.

There are three main types of HES spiral heat exchangers: Type A, B and C.
The main characteristics of these types are:

Type A: - Counter- or co-current flow
- Both covers onto the spiral body

Type B: - Cross flow
- Free space between covers and the spiral body

Type C: - Cross-/counter- or cross-/co-current flow
- One cover onto the spiral, one with free space between cover and spiral body

In general, the type description is as follows:

Type – Channel closure inner channel / Channel closure outer channel – Centre-type – Mounting

For example: *A – OR / OR – 1A - V*

here is:

Type:	A, B or C (as described in detail below)		
Channel closure:	OR	=	Open-Roll
	OO	=	Open-Open
	RR	=	Roll-Roll
	OB	=	Open-Bar
	BB	=	Bar-Bar
	OBO	=	Open-Bar-Open
Centre type:	e.g. 1A (execution of the centre, see detailed drawings, if supplied)		
Mounting:	horizontal (H) or vertical (V)		

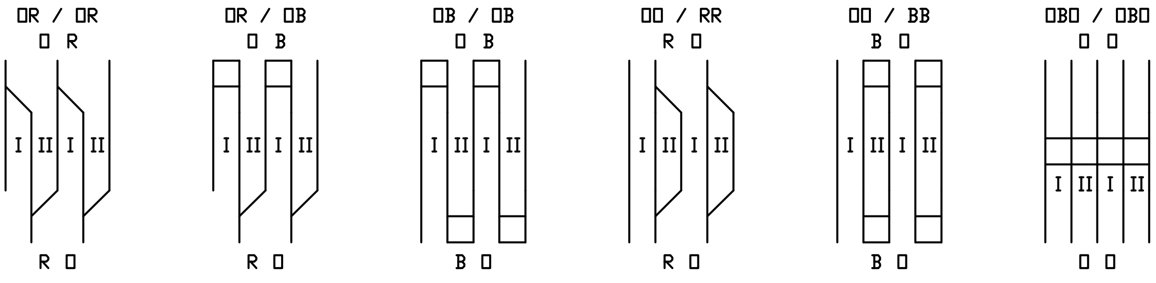


Fig.2.1: Examples of channel closures

2.1 Type A

Spiral heat exchangers can be arranged in co- or counter-current flow (see figure 2.2 and 2.3). Two main versions of type A can be distinguished.

Version A-1
- Channels alternately welded
- Both covers can be removed and both channels are accessible

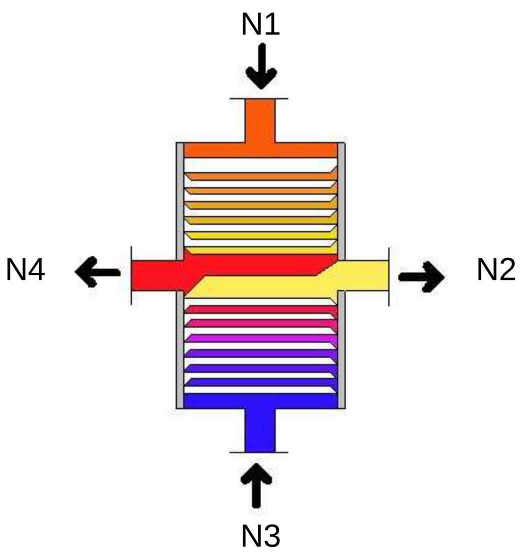


Fig.2.2: Type A-1 Co-current flow

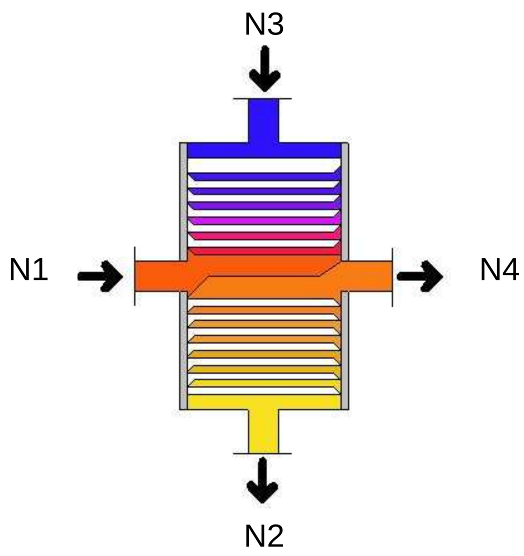


Fig.2.3: Type A-1 counter-current flow

Version A-2
- one channel is closed on both sides and not accessible
- the other is open on and accessible from both sides

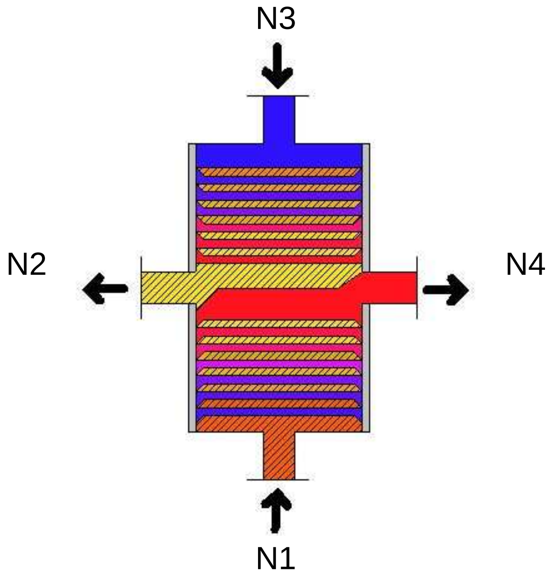


Fig.2.4: Type A-2 Co-current flow

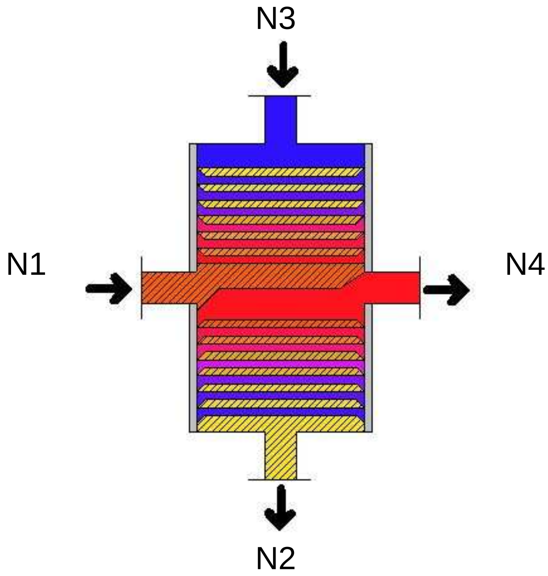


Fig.2.5: Type A-2 counter-current flow

Nozzle schedule for type A

N1	- Hot fluid inlet	N3	- Cold fluid inlet
N2	- Hot fluid outlet	N4	- Cold fluid outlet

2.2 Type B

There are two versions of this type.

Version B-1
- one channel closed on both sides
- one fluid flows in cross flow through the open channel
- Flow arrangements as in depicted in Fig. 2.6, 2.7 and 2.8

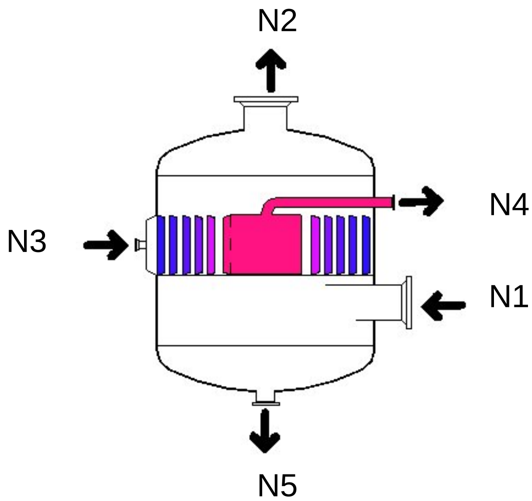


Fig. 2.6: Type B-1a

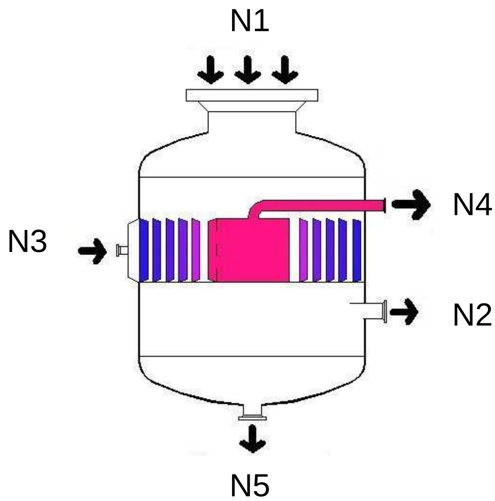
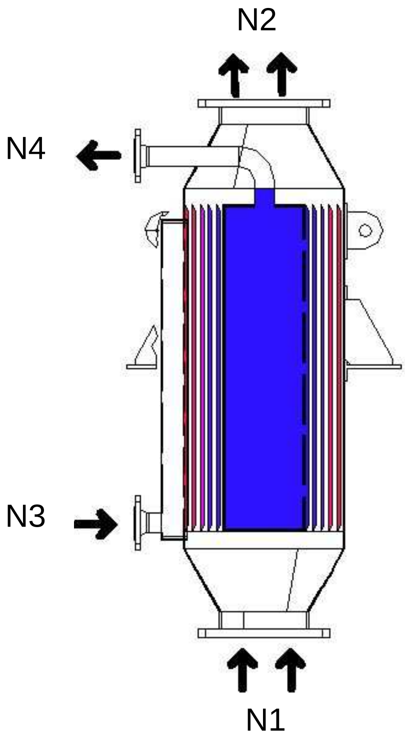


Fig. 2.7: Type B-1b



Nozzle schedule for type B-1

N1 - Vapour inlet
N2 - Vapour/Inert-gas outlet
N3 - Cooling fluid inlet
N4 - Cooling fluid outlet
N5 - Condensate outlet

Fig. 2.8: Type B-1c (vertical mounting)

Version B-2

- Overhead condenser
- one channel closed on both sides
- the condensing fluid flows through the open channel

The condensate is collected at the condenser bottom and removed, or falls down in droplets, as for example in dephlegmator-applications. Inert gases can be removed.

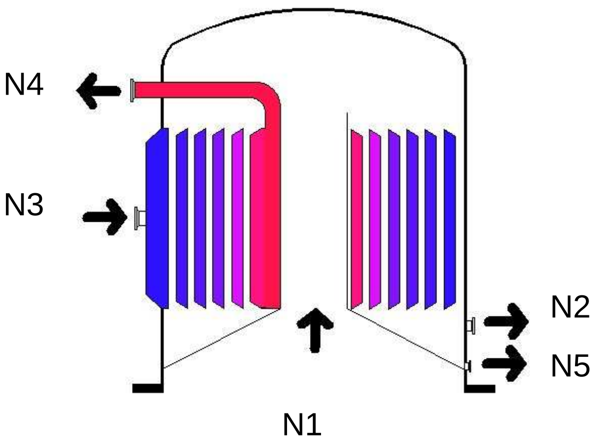


Fig. 2.9: Type B-2a

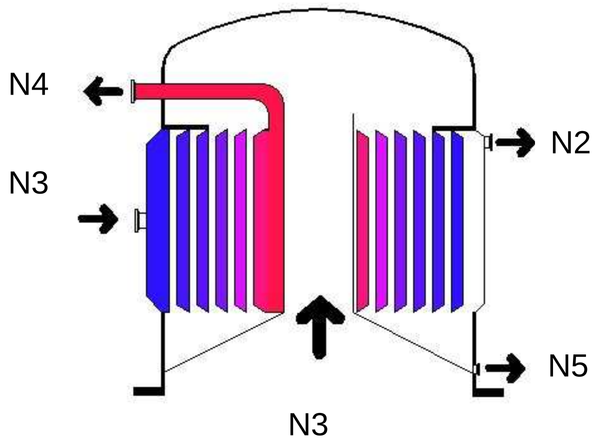


Fig. 2.10: Type B-2b

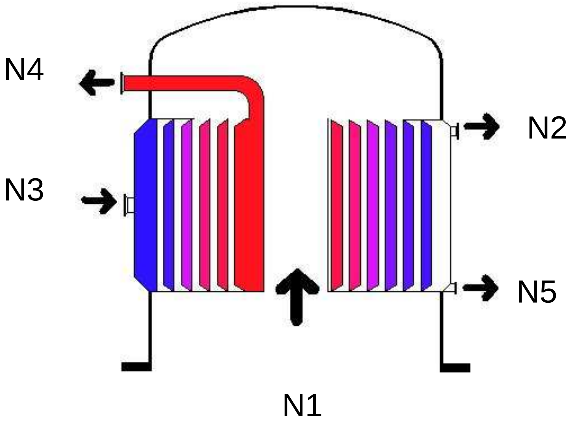


Fig. 2.11: Type B-2c

Nozzle schedule for type B-2

N1 - Vapour inlet
N2 - Vapour/inert gas outlet
N3 - Cooling fluid inlet
N4 - Cooling fluid outlet
N5 - Condensate outlet

2.3 Type C

Type C can be used, for example, to heat particle-containing fluids (horizontal mounting), to condense vapour and sub-cool the condensate/inert gas, or combine condensation and evaporation into a single unit. The figures 2.12 /.13 /.14 show application examples.

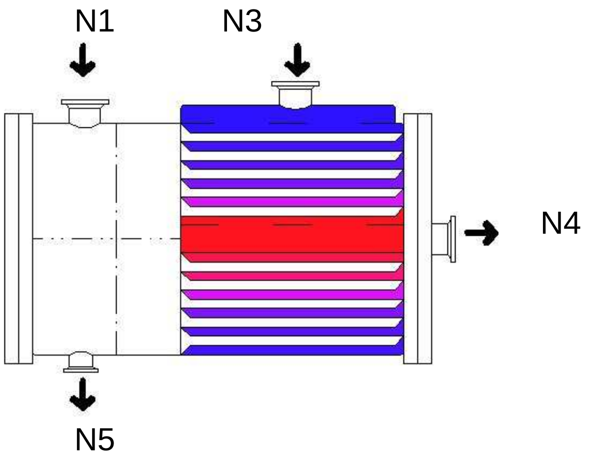


Fig. 2.12: Type C-1a (horizontal mounting)

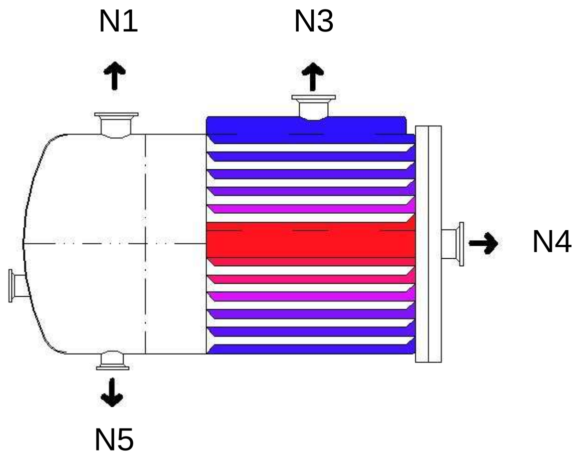


Fig. 2.13: Type C-1b

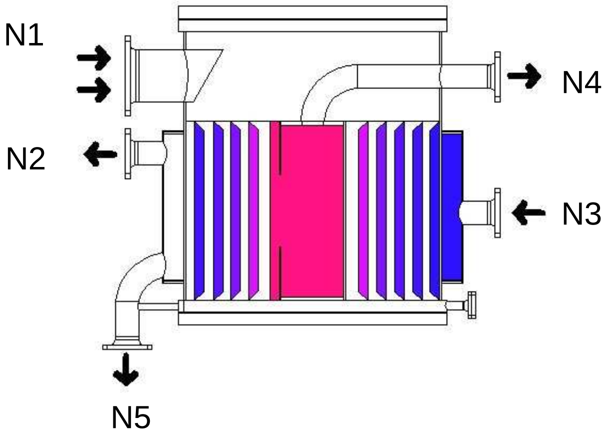


Fig. 2.14: Type C-1c

Nozzle schedule for type C-1

N1 - Vapour inlet
N2 - Vapour/Inert gas outlet
N3 - Cooling fluid inlet
N4 - Cooling fluid outlet
N5 - Condensate outlet

3 Storage

In the case that the spiral heat exchanger is not installed immediately, appropriate storage measures need be taken to avoid damage. Apart from dry and clean storage of the unit, the nozzle openings shall be covered with caps or the entire unit can be filled with nitrogen. Indoor storage at a temperature of about 20℃ (68℉) and a relative humidity of about 70% is recommended. Long time storage is done preferably in a wooden crate of the seaworthy packing type.
The transport packing of the heat exchanger shall be removed only shortly before installation.

4 Installation

4.1 Transportation

The transportation and lifting of the spiral heat exchanger is done while observing the applicable local safety regulations. Lifting of the unit must occur by lifting the unit in its transport packing or by its lifting lugs. If there are no lifting lugs, put belts around the unit. Do not lift or move the unit by using flanges or nozzles as lifting lugs.

4.2 Mounting

Prior to installation, it must be verified that the floor can withstand the full assembled weight of the heat exchanger filled with water or with process fluid, whichever is heavier. If anchor bolts are required to prevent the unit from falling over (e.g. when opening the covers), then these are to be installed properly. HES cannot accept responsibility or liability for incorrectly installed anchor bolts.
The spiral heat exchanger shall be installed as shown on the general arrangement drawing.

The correct installation of the spiral heat exchanger with a frame is done as follows:

- Level the frame
- Loosen the bearing bolts

- Level the nozzles – level the unit according to the nozzle positions
- Tighten the bearing bolts: outer bolts first; then the middle bolt

4.3 Access to the unit

Do reserve sufficient space around the unit for removing pipework and the covers of the units and/or for opening the covers, if hinged.

4.4 Connections

Prior to connecting the nozzles, do remove the nozzle caps and inspect the inside for the presence of foreign material or debris that may have entered during transport.

When designing the pipe work around the unit, do include by-passes so that the unit can be taken out of service and removed from its part of the plant. The following flow sheet shows, as an example, the pipe work and valves around the unit.

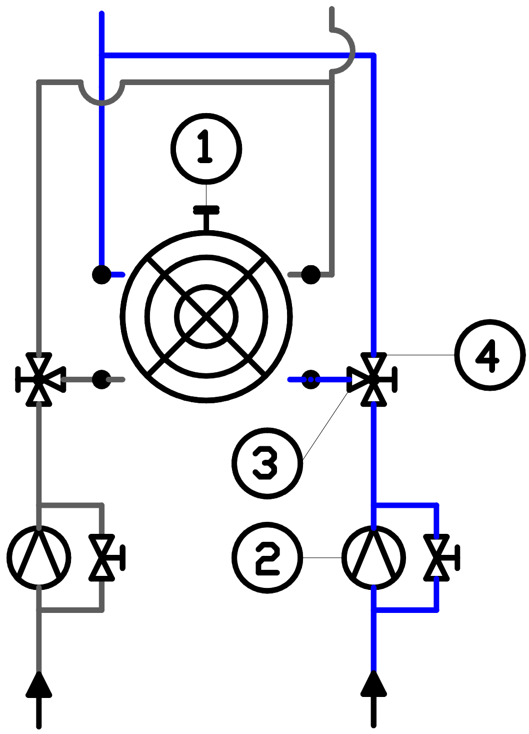


Fig. 4.3: Example of connecting the heat exchanger

If not already present, the pipes to and from the spiral heat exchanger shall be preferably provided with manometers and thermometers, so that the operation of the heat exchanger can be verified. Flow meters can be useful too.

4.5 Protection against abnormal mechanical shock

If, during operation, pressures higher than the design pressure of the unit can occur, the unit must be protected with over-pressure protection devices such as rupture discs.

If the spiral heat exchanger is operated with steam, the steam supply pipes must include control valves or three-way valves. Do not use short valve-action valves. Furthermore, do include a steam trap preferably with automatic venting of non condensibles.

To withdraw the condensate, the corresponding pipe should be sufficiently sized.

Do not use reciprocating (piston-type) pumps or in general pumps that cause pulsation of flow, which may cause damage to the heat exchanger. If such pumps are inevitable, do take appropriate measures to damp the pulsation, e.g. include buffer tanks. In between the pump and the heat exchanger always include a valve.
In the specifications of pumps and heat exchangers ample margins shall be taken for pressure drop increases above the stated design values. Such increased pressure drops may stem from varying physical properties, flow rates or forms of fouling or a combination of those.

The pipes connected to the unit must be supported well to avoid nozzle loads, caused, fro example, by thermal expansion. Do not exceed the maximum nozzle loads, which, when allowed, are stated in the documentation supplied with the unit.

5 Commissioning and operation

Prior to start-up, all design data shall be verified against the expected operating data. Do not put the unit into operation, if the maximum expected temperature, pressure and/or flow rate exceed(s) the design value(s). Cyclic loads of operation must be avoided, as the heat exchanger is not designed for cyclic operating conditions. During start-up, operation and/or shut-down, temperature and/or pressure shocks must not occur.
During transportation or long storage, the bolts may have become looser, possibly also because of the gasket setting. Prior to start-up, the correct tightening of the bolts should be verified and, if necessary, bolts should be tightened. Do not exceed the torque stated on the general arrangement drawing.

Based on our experience, we recommend the following:

- Start-up with the cold side first to avoid heating up of the unit
- The flows should be increased gradually to avoid hydraulic shocks; slow-action valves should be used!
- When shutting down, close the hot side first
- **Important:** At operating temperatures above 100℃ (212℉), do increase the temperature gradually with no more than 50℃ (122℉)/h.

If above procedures are not followed, the unit could fail.

With reference to the flow sheet of fig. 4.3, which shows the connection of the spiral heat exchanger, please note the following detailed start-up procedure.

- Open the vent (1)
- Fill the channel
- Close the vent (1)
- Start the pump (2), the inlet valve (3) is closed; the by-pass (4) is open
- Gradually open the inlet valve (3), close the by-pass (4)
- Verify that air or gas is completely removed from the heat exchanger and/or the main pipe. Horizontal units are generally self-venting through the shell nozzles if installed above the unit
- Continue with the hot side by taking the above steps in the same order

Shutting down takes place in the reverse order!

During operation, the flows should be as much as possible as designed. At lower velocities, heat transfer efficiency and pressure drops are lower. Low velocities increase the risk of fouling; in case of particle containing fluids, the particles may settle and eventually block the flow passage.
If, in the case of more parallel units, the flow is to be reduced greatly, it is preferred to take one or more units out of service rather than to reduce the flow over all units arranged in parallel.

6 Shut-down

Before shutting down, or coming to a short stand still, appropriate preparation is required, so that the shut-down or opening of the unit can be done safely.

- Close pipes from and to the heat exchanger or open the by-pass valves
- Relieve the pressure from the spiral heat exchanger → open the vents
- The temperature of the hot and cold fluids should be allowed to reach ambient temperature

In the case of a short stand still and if the unit need not be opened, it is possible to leave the heat exchanger filled. Also in this case, however, the vents shall be opened. If the fluids are corrosive or cause easy fouling, the unit shall be flushed, even in the case of a short stand still. If the unit remains filled with water, do verify that the Chlorine concentration of the water is sufficiently low to avoid pitting corrosion.
In the case of frost risk, the unit need be emptied entirely or filled with an appropriate fluid.

Units containing fluids with a normal boiling point well below ambient temperature (e.g. Freon or ammonia) must not be allowed to reach ambient temperature with closed values. Although the spiral heat exchanger is designed to withstand the pressures generated, there is a risk of personal injury, if the unit is opened, while still containing these fluids. The working fluid pipe work systems shall be so arranged that continuous venting is provided.

Emptying of the unit is carried out by means of the drains and/or valves. If no drain nozzle is installed, arrangements need be taken to collect the fluid from the unit, when it is opened. The volume per channel is found on the general arrangement drawing.
If the unit is returned to the manufacturer for repair, then it must have been properly emptied and cleaned with water or a cleaning agent before. This is required to meet the safety requirements during transportation and opening at the manufacturer’s work shop.

7 Maintenance

7.1 General

It is recommended to clean the unit preventively to maintain the maximum efficiency and to avoid corrosion caused by fouling of, for example, Chloride-containing residuals.
The unit can be cleaned mechanically, through high-pressure water or steam, or chemically, through suitable cleaning agents or solvents. Do verify, before use, that the cleaning agent (even if water) or solvent cannot react with the material of construction, the gaskets or with fluid residuals in the unit.

7.2 Mechanical cleaning

Depending on the channel spacing and coil width, mechanical cleaning of the opened unit can be done by means of a high-pressure lance. Do avoid high temperature differences between the water/steam and the unit to avoid possible stresses.
Also, cleaning is possible through brushing or similar, as long as the heat transfer surface is not scratched or otherwise damaged.

7.3 Chemical cleaning

The pipe work must be designed so that the cleaning agent or solvent can flow in a closed circuit through the unit. When using cleaning agents or solvents the applicable safety and environmental regulations and procedures shall be followed.
The back-flush method has been proven as effective. In this case, the cleaning agent or solvent is pumped through the unit in the opposite direction as the operating fluid. The flows are preferably equal or greater than flows of the fluids during normal operation. If this is not feasible, longer circulation times shall be applied.
At all times, the unit's maximum design temperature and pressures must be observed.

7.4 Repair

Depending on how the unit is damaged or leaks (see section 9.3 for the test method), different repair possibilities may exist.
At all times, our technical department shall be contacted to establish together the best repair alternative.

Important! – Do take note of Section 1, before executing any repair.

8 Opening and closing of the spiral heat exchanger

8.1 General

Shut-down procedures are described in Section 6. Prior to executing any work on the unit, do verify that the pressure is relieved. If bolts are removed from a unit under pressure, these may jump away at once with direct risk of personal injury.

Care is to be exercised if the gaskets need be removed to avoid scratches to the cover and seating area.

8.2 Opening and closing procedures

Important: frame-mounted and horizontally operated units need be moved in the vertical position first. Removal of the cover in the horizontal position alters the centre of gravity as a result of which the unit could start to turn by itself with the risk of personal injury.

Prior to the removal of the covers, the corresponding pipe work need be removed and the lifting device is connected to the lifting lug. Then, the bolts or hook-bolts can be undone and the cover removed. The other cover is removed in the same manner.

The covers are assembled in the reverse order.

The following need be observed during cover assembly:

- Carry out an inspection as described in Section 9.1
- Damaged or defective (hook-) bolts need be replaced or the thread eased
- Damaged or defective gaskets are replaced
- Clean the seating area, remove particles
- Position the gasket
- Distribute the hook-bolts equally over the circumference of the unit
- Grease the bolts so that the required torque can be applied
- Centre bolts, if present, need be tightened first, apply order of fig. 8.1
- Tighten the bolts in the order as depicted in fig. 8.1
- The maximum applicable torque is indicated in the general arrangement drawing

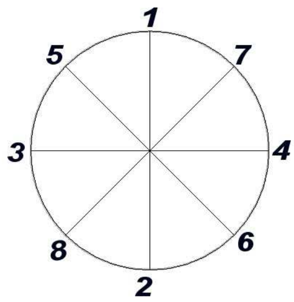


Fig.8.1: Order for tightening bolts

8.3 Opening and closing condensers

In the case of spiral heat exchangers of type A and C, if one channel is welded at both ends as in „roll-roll“, the lower cover may be removed only in horizontal position to avoid that the spiral body moves downwards. During operation, the spiral body is kept in place by the cover.

Important: If the unit is frame-mounted, it must be secured in horizontal position before removing the cover, so that it cannot turn by itself after having removed one cover.

The procedure is as described in Section 8.2.

9 Tests

9.1 Inspection

Before assembling the covers, both channels shall be inspected thoroughly for, for example, plate deformations, fouling or blockage, corrosion or erosion.
Fouling or blockages can be removed by cleaning as described above. Damage or deformations are best reported to the manufacturer to discuss remedies.

9.2 Hydrostatic test

After assembly of the gaskets and the covers, a hydrostatic test is carried out subject to the applicable Code requirements. The maximum test pressure is indicated on the general arrangement drawing.

9.3 Perl-test

In the case leakage is suspected, a leakage test (Perl-test) shall be carried out to establish its location. Prior to the test, the unit need be emptied and cleaned. All tools used for the Perl-test shall be able to withstand the test pressure.
The Perl-test can be executed on site, following the procedure described here.

- One channel of the unit is closed with gasket and cover; the unit is brought to the vertical position
- The other channel remains on top and open and is filled with water
- Over the spiral body, a cross bar is applied to avoid telescoping (moving upwards) of the spiral after having applied the Perl-test pressure.
- Slowly increase the pressure of the air in the closed channel to a maximum of 0.5 bar(g) – 7 psi(g). If, during the pressure increase, leakage occurs on the closed side, relieve the pressure and check the gasket.
- After having reached the Perl-test pressure, check the water surface.
- Keep the pressure for about 30 minutes and check the water surface regularly.

During the pressure increase and when the Perl-test pressure is reached, small bubbles can reach the water surface. These must not indicate a leakage, but could be the result of water de-aerating.
If, after 30 minutes, bubbles keep reaching the surface, there is a leakage. Mark the location of the bubbles.

9.4 Repair

For repair of leakages, please refer to Section 7.4

10 Trouble-shooting

Problem	Possible cause	Solution
During start-up, the duty is not reached	- Air or entrained gas in the channels - Too low flow rate of the fluids	- Vent - Check flow rate and fluid temperature
The duty decreases, pressure drop increases	- Fouling of clogging of the channel	- Clean - Check flow rates
Die duty and pressure drop decrease	- Gasket not in place of defect leading to bypass over the spiral body - Flow rate too low	- Check the gasket and its position - Check operating pressure and flow
Duty decreases, the temperature does not increase	- Air or entrained gas in the unit	- Vent - Check venting valves
Pressure drop increases (strongly), duty remains equal	- Fouling and/or clogging of in- and/or outlet nozzles	- Cleaning by back-flush
External leakage, fluids leaves unit	- Cover gasket damaged - Flange gasket damaged - Operating pressure too high, leakage between cover and gasket - Unequal distribution of hook-bolts after assembly - Thermal expansion during start-up	- Replace gasket - Correct pipe position - if req., replace gasket - Check operating pressure. If pressure is correct, tighten bolts - Improve distribution and tighten - Check hook-bolts, if leakage remains, - Check/replace
Internal leakage	- Plate damage through erosion, corrosion or mechanical stress/damage	- Contact HES, check repair possibilities

Tab. 10.1: Trouble-shooting liquid/liquid-application

Problem	Possible cause	Solution
Fast and strong decrease of duty with increasing vapour-side pressure drop	- Inert gases(non-condensibles insufficiently removed	Check operating data and if required, improve venting system/vacuum
Cooling fluid or condensate outlet temperature varies, duty variable, condensation occurs	- Insufficient withdrawal of condensate - Insufficient vapour	Change condensate system, use or increase capacity condensate pump Increase vapour flow; contact HES to establish actual duty

Tab. 10.2: Trouble-shooting for condensers

Problem		Possible cause	Solution
Duty unsteady and varies	-	Different operating conditions compared to design	Change operating conditions (temperatures, flow rates, pressures) according to design
	-	Insufficient fluid flow on evaporating side	Increase flow or pump capacity

Tab. 10.3: Trouble-shooting for evaporators

11 Spare parts

Under normal circumstances, only the gaskets under the covers and cover (hook-) bolts are required as spare parts.
Per operating year, it is recommended to keep in stock two sets of cover gaskets and 10% bolting.

In the case of ordering spare parts, please communicate the unit's order and serial number. Both numbers are on the nameplate and in the documentation supplied with the unit.

12 Contact

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