

Vapour Heat Exchangers

VHE



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1 Safety information

Safe operation of these products can only be guaranteed if they are properly installed, commissioned, used and maintained by qualified personnel (see Section 1.11 on this document) in compliance with the operating instructions. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

1.1 Intended use

Reference these Installation and Maintenance Instructions, the name-plate - Figure 1, and the Technical Information sheet or relevant documentation to ensure that the product is suitable for the intended use or application.

The products listed on the adjacent table comply with the requirements of the EU Pressure Equipment Directive/UK Pressure Equipment (Safety) Regulations and carry the  mark when so required.

The products fall within the specified Pressure Equipment Directive categories as shown in Table 1.

Vapour type heat exchangers fully comply with the requirements of the ASME Boiler and Pressure Vessel Code and carry the "U" ASME Stamp when so required.

- i) The products have been specifically designed for use on steam, air or water which are in Group 2 of the above mentioned Pressure Equipment Directive. GESTRA should be contacted to confirm the suitability of the product for use on alternative fluids and applications.
- ii) Check material suitability, pressure and temperature and their maximum and minimum values. If the maximum operating limits of the product are lower than those of the system in which it is being fitted, or if malfunction of the product could result in a dangerous overpressure or overtemperature occurrence, ensure a safety device is included in the system to prevent such over-limit situations.
- iii) Determine the correct installation situation and direction of fluid flow.
- iv) GESTRA products are not intended to withstand external stresses that may be induced by any system to which they are fitted. It is the responsibility of the installer to consider these stresses and take adequate precautions to minimise them.
- v) Remove protective covers from all connections and protective film from all name-plates, where appropriate, before installation on steam or other high temperature applications.

Table 1 Standard VHE PED categorisation

Shell Ø"	Rating	Shell length (mm)	VHE PED Cat.
1½"	PN16	1000	SEP
2"		1000	SEP
3"		1000	SEP
4"		1000	1
6"		1000	1
8"		1000	2
10"		1000	2

Product name-plate

The product is fully compliant with the requirements of the EU Pressure Equipment Directive/UK Pressure Equipment (Safety) Regulations and carries the  mark when so required.

Each name-plate is fixed to the shell of the unit and confirms the following information:

- Serial number, year of manufacture and heat exchanger type and name-plate.
- Equipment categorization: according to the directive.
- Fluid group, both shell and tube side according to the directive.
- Test pressure according to the directive.
- Design condition: both shell and tube side maximum allowable pressure and temperature.
- Weight of empty unit.
- Volume both shell and tube side.

Note: A different kind of approval with certification from a notified body may be possible for bespoke units.

Note:

This document refers only to the mechanical installation and commissioning of the heat exchanger and should be used in conjunction with the relevant instruction and installation manuals for other system components and supplementary safety information for all the system components.

Warning

This product is designed and constructed to withstand the forces encountered during normal use. Use of the product for any purpose other than its intended use could cause damage to the product and may cause injury or fatality to personnel.

Before any installation or maintenance procedure, always ensure that all primary steam and condensate return lines and secondary water lines are isolated.

Ensure any residual internal pressure in the system or connecting pipework is carefully relieved. Allow hot parts to cool before commencing work, to avoid the risk of burns.

Always wear appropriate safety clothing before carrying out any installation or maintenance work.

Access

Ensure safe access and if necessary a safe working platform (suitably guarded) before attempting to work on the product. Arrange suitable lifting gear if required.

1.2

Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required.

1.3

Hazardous liquids or gases in the pipeline

Consider what is in the pipeline or what may have been in the pipeline at some previous time. Consider: flammable materials, substances hazardous to health, extremes of temperature.

1.4

1.5 Hazardous environment around the product

Consider: explosion risk areas, lack of oxygen (e.g. tanks, pits), dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery. The system must not be used in potentially explosive atmospheres.

1.6 The system

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolation valves, electrical isolation) put any other part of the system or any personnel at risk?

Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms. Ensure isolation valves are turned on and off in a gradual way to avoid system shocks.

1.7 Pressure systems

Ensure that any pressure is isolated and safely vented to atmospheric pressure.

Consider double isolation (double block and bleed) and the locking or labelling of closed valves. Do not assume that the system has depressurised even when the pressure gauge indicates zero.

1.8 Temperature

Allow time for temperature to normalise after isolation to avoid danger of burns.

1.9 Tools and consumables

Before starting work ensure that you have suitable tools and/or consumables available. Use only genuine replacement parts.

1.10 Protective clothing

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

1.11 Permits to work

- All work must be carried out or be supervised by a suitably competent person.
- Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions.
- Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.
- Post 'warning notices' if necessary.

Handling

1.12

Manual handling of large and/or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

Residual hazards

1.13

In normal use the external surface of the product may be very hot. If used at the maximum permitted operating conditions the surface temperature of some products may reach temperatures of 300 °C (572 °F).

Many products are not self-draining. Take due care when dismantling or removing the product from an installation (refer to 'Maintenance instructions').

Freezing

1.14

Provision must be made to protect products which are not self-draining against frost damage in environments where they may be exposed to temperatures below freezing point.

Disposal

1.15

Unless otherwise stated in the Installation and Maintenance Instructions, this product is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken.

Returning products

1.16

Customers and stockists are reminded that under EC Health, Safety and Environment Law, when returning products to GESTRA they must provide information on any hazards and the precautions to be taken due to contamination residues or mechanical damage which may present a health, safety or environmental risk. This information must be provided in writing including Health and Safety data sheets relating to any substances identified as hazardous or potentially hazardous.

2 Storage

2.1 General storage

Note: If the heat exchanger cannot be installed and put into operation immediately upon receipt then certain precautions are necessary to prevent deterioration during storage. Responsibility for integrity of the heat exchangers must be assumed by the user. GESTRA will not be responsible for damage, corrosion or other deterioration of heat exchanger equipment during transit and storage.

Good storage practices are important, considering the high costs of repair or replacement, and the possible delays for items which require long lead times for manufacture. The following suggested practices are provided solely as a convenience to the user, who shall make his own judgement on whether to use all or any of them.

2.1.1 On receipt of the heat exchanger, inspect all protective covers for shipping damage. If damage is evident, inspect for possible contamination and replace protective covers as required. If damage is extensive, notify the carrier immediately and GESTRA.

2.1.2 If the heat exchanger is not to be placed into immediate service, take precautions to prevent oxidation or contamination.

If it is planned to install the heat exchanger after two weeks from delivery it is recommended that the following procedure is implemented:

- Remove the possibility of humidity from both tube side and shell side by circulating hot air.
- Close off the connections with blind flanges.
- Install a manometer.
- Fill the tube and shell side with nitrogen up to 0.5 bar (7 psi).

2.1.3 Remove any accumulation of dirt, water, ice or snow and wipe dry before moving exchangers from outside to inside storage. If the unit was not filled with nitrogen or other preservative, open the drain plugs to remove any accumulated moisture, then reseal. Accumulation of moisture could indicate oxidation has already started and remedial action should be taken.

2.1.4 Store under cover in a heated area, if possible. The ideal storage environment for heat exchangers and accessories is indoors, above ground, in a dry, low humidity atmosphere which is sealed to prevent entry of dust, rain or snow. Maintain temperatures between 20 °C and 50 °C (68 °F to 122 °F) and humidity at 40% relative humidity or lower.

Note: Ambient temperature of the place where the unit will be installed must be between -10 °C and 50 °C (14 °F to 122 °F).

2.1.5 In tropical climates, it may be necessary to use trays of renewable desiccant (such as silica gel), or portable dehumidifiers, to remove moisture from the air in the storage area. Thermostatically controlled portable heaters (vented to outdoors) may be required to maintain an even air temperature inside the storage area.

Note: Advisable to inspect the heat exchangers and accessories frequently while in storage.

Description

3.1

The GESTRA VHE is based on the vapour heat exchanger with an additional connection and utilises flash steam from discharge and exhaust vent pipework to pre-heat make-up or process water thereby recovering valuable heat energy that would otherwise be lost to atmosphere.

The GESTRA VHE will improve steam system efficiency and is environmentally friendly, reducing CO₂ + carbon emissions and removing visible discharges from the atmosphere whilst saving valuable energy.

It is easy to install and provides an optimised heat transfer solution when compared to other heat exchanger designs used in similar applications.

As standard the construction is completely stainless steel and the tube side is all in AISI 316. There are no gaskets (with the exception of the piping connection) and no painted components.

The heat-exchanging surface is of straight corrugated tubes designed for low viscosity fluids and for turbulent flow working conditions.

The tube sheets are of an integral type and are supplied ready for installation.



Fig. 1

3.2 Pressure/temperature limits

TMA	Maximum allowable temperature	Shell side	6 bar g (87 psi g)	300 °C (572 °F)
		Tube side	12 bar g (174 psi g)	200 °C (392 °F)
PMA	Maximum allowable pressure	Shell side	-10 °C to +200 °C (14 °F to 392 °F)	12 bar g (174 psi g)
		Tube side		

Notes:

- 1. The above information is relevant for standard vapour heat exchangers, for further product technical data see the relevant Technical Information sheet.
- 2. For bespoke vapour heat exchangers appropriate documentation will be supplied with the unit.

Warning: Bespoke units can be designed according to different criteria than standard units, always refer to the data on the name-plate for the ultimate design limits.

Transport

4.1

Each unit is individually packed in a special carton box with suitable legs for lifting with a fork lift truck. Suitable spacers are put in the box to avoid damage during transit.

The total weight is indicated outside of the box.

For length out of standard special pallets are used to allow fork lifting or the units are fitted with lifting legs attached to the heat exchanger to provide a means for lifting and moving the units.

Operating conditions

4.2

Before every live run, check that the operating conditions specified are within the limits indicated on the name-plate. Procedures detailed in this document are valid for all GESTRA fixed tube heat exchangers. See the design specifications of each unit as well as the name-plate attached to the exterior of the heat exchanger for design specification and maximum operating conditions of each unit.

Follow the in-out connections of fluids as per the project system design.

4.3

Hot side – cold side

If the primary fluid is steam, superheated water, or diathermic oil, note that the system design has been made providing connection on the shell side.

This principle becomes mandatory as the operating conditions approach the limits specified on the name-plate, and as the difference in temperature increases.

Should such circumstances arise, GESTRA can only accept responsibility for the system design when these conditions are adhered to. If these conditions are not met by the purchaser or his agent, the manufacturer's guarantees and responsibilities will also be automatically invalidated.

Due to the design features, this Series of heat exchanger can be installed in almost any position and with any direction of secondary flow. However, for maximum performance, countercurrent flow is advisable. To minimize the space required, the system should be positioned vertically. A vertical installation with tube side flow from top downwards will make it more difficult for substances to adhere to the walls and make it easier to expel the lime scale and dirt from the heat exchanger. This provides an effective trap for impurities and encrusted sedimentation. Figures 3 and 4 illustrate all possible installation positions.

4.4

Warning: A suitable space around the heat exchanger is to be advisable for maintenance, in accordance with local current legislation.

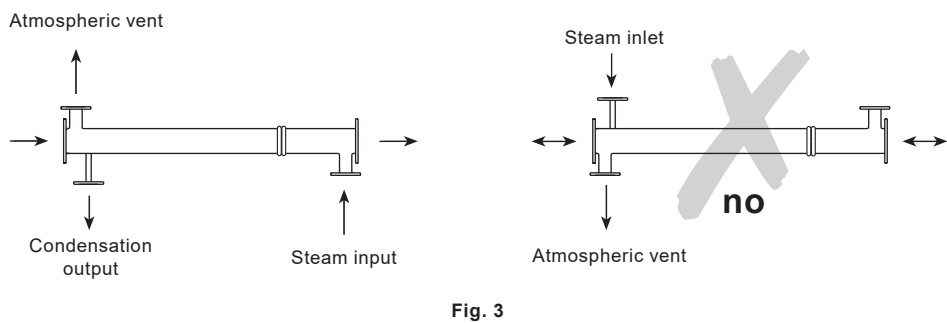
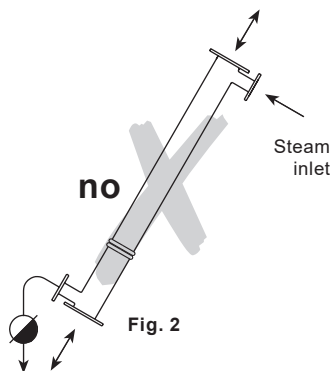


Fig. 2 and 3 - Position when the shell side fluid is condensing steam

Foundations and/or supports must be adequate so that exchangers will not settle and cause piping strain. Saddle bolts should be set to allow for setting inaccuracies.

Warning: Only one end of the heat exchanger must be fixed. The other end must be allowed to move axially on a specially constructed sliding guide (Figure 4), to allow for the normal expansion of the heat exchanger tubes, which results in the system lengthening axially, and varies depending on the operating temperature.

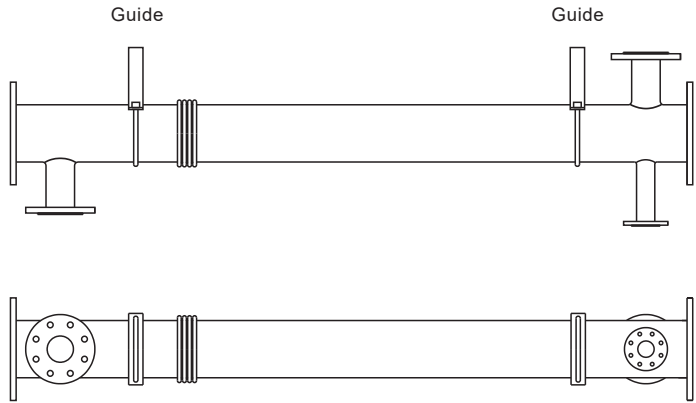


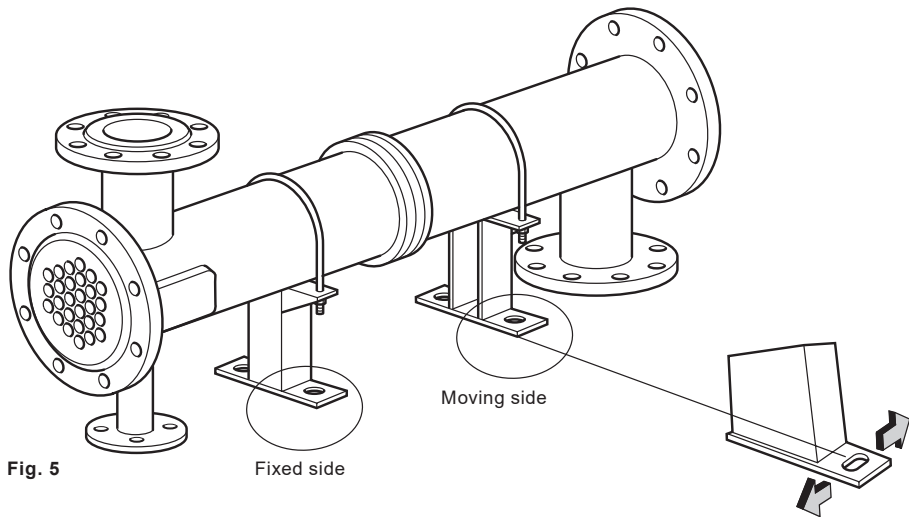
Fig. 4

Table 2 displays the axial expansion that can result, depending on the temperatures to which the heat exchanger tubes are subjected.

Table 2 Axial expansion (approximate) in mm (inches)

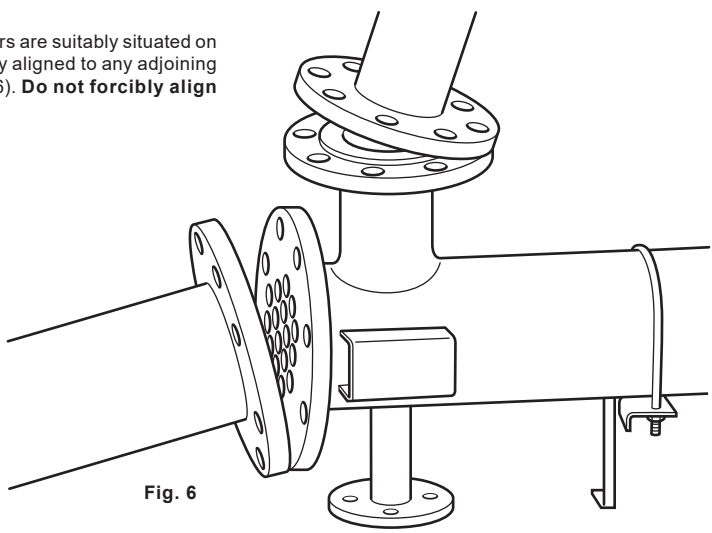
Tube wall temperature	50 °C (122 °F)	100 °C (212 °F)	200 °C (392 °F)	300 °C (572 °F)
Exchanger length	Stainless steel	Stainless steel	Stainless steel	Stainless steel
1 metre (39")	0.46 (0.01")	1.3 (0.05")	3 (0.11")	4.8 (0.18")

4.6 Loosen the saddle bolts at one end of unit to allow free expansion (Figure 5).



Caution: Provision must be made to isolate the heat exchanger from any external vibration sources that could cause tube failures within the heat exchanger. Neglecting this provision, internal leakage and mixing of the hot and cold media could happen.

4.7 Ensure that heat exchangers are suitably situated on a level surface and are fully aligned to any adjoining pipe connections (Figure 6). **Do not forcibly align the connections!**



External loads

None of the existing design codes (EN; ASME... etc.) provide rules that define limits on the external loads or operating conditions. External loads can be due to wind, earthquake or piping supports. The connecting piping, if incorrectly installed, generates the most common external forces and moments on the nozzles of heat exchanger.

These loads are rarely known and depend on how the piping system is made.

Generally, the piping layout must be engineered and installed so that 'No loads' are applied to the heat exchanger nozzles. The piping system must be adequately supported to avoid these forces.

When pipe loads are unavoidable, they must be calculated to define the size and direction of the possible 3 forces and 3 moments axis applied to each nozzle. It is almost impossible for GESTRA to predefine these forces because there are infinite combinations of loads and as a consequence an infinite number of possible stress levels on the heat exchanger.

If there is any doubt during the installation contact GESTRA. An Engineer will be able to verify the loads and give the necessary support to correctly install the heat exchanger.

Caution: All system piping to the heat exchanger must be adequately supported. Failure to do so will result in excessive loads on the connections of the heat exchanger causing damage and/or leakage that may inflict a potential injury to adjacent personnel.

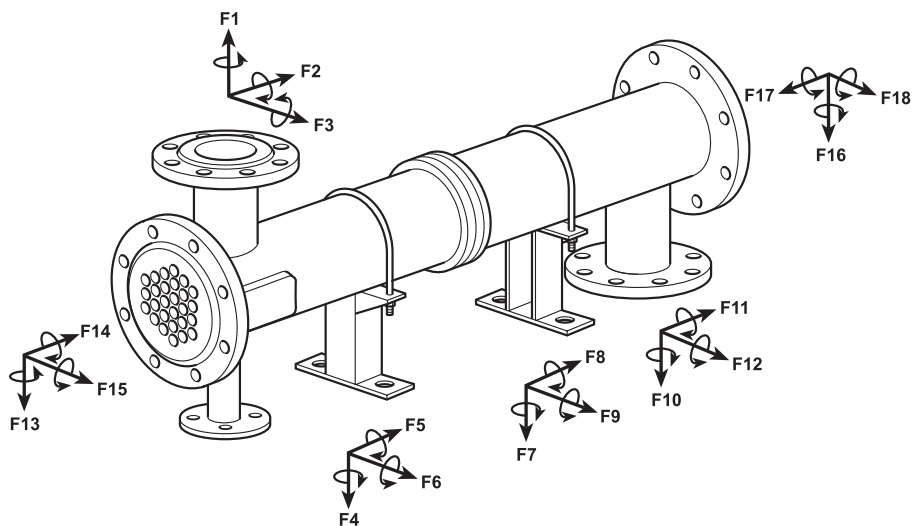


Fig. 7

Caution: All system piping on the heat exchanger's moving side must allow the axial movements of the heat exchanger. Failure to do so will result heat exchanger leakage and mixing of the two fluids.

- 4.9** Figure 9 illustrates the possible tubing connections. It is also acceptable to use large bended tubes or flexible connections.
- 4.10** To protect the expansion joint from external damage and optimise energy consumption, it is advisable to use a polyurethane insulating jacket as shown in Figure 9.
- 4.11** Connect the heat exchanger to an earth point.
- 4.12** Inspect all flanges on the heat exchanger for foreign material. Remove all plugs and shipping pads just before installing.
- 4.13** Ensure that the entire system is clean before commissioning to prevent blocking of the tubes. The use of strainers in settling tanks in pipelines leading to the unit is recommended.
- 4.14** Ensure adequate isolation valves are installed for inspection, cleaning or repair work to be carried out.
- 4.15** Provide thermometer wells and pressure gauge connections in all piping to and from the unit and located as near to the unit as possible.

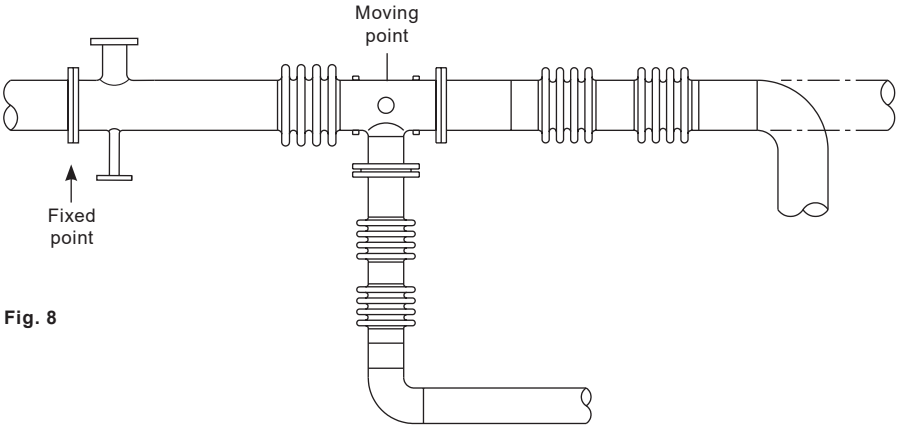


Fig. 8

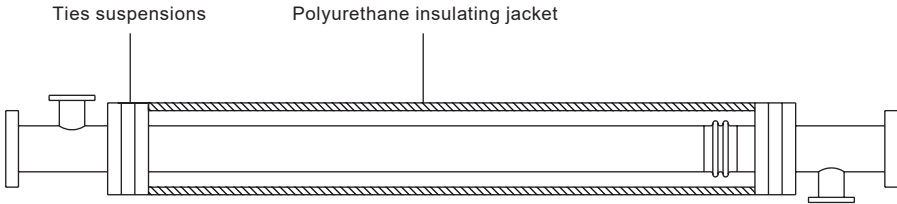


Fig. 9

Do not operate equipment under conditions in excess of those specified on the name-plate.

5.1

Warning: Failure to operate the heat exchanger within the design pressure and temperature limits (as specified on the name-plate) may result in damage to the heat exchanger and potential injury to adjacent personnel.

Fluid and/or steam velocities in excess of the design operating conditions on either the shell or tube side of the heat exchanger can cause damage (tube erosion and/or vibration). The direct result of this is internal leakage and mixing of the hot and cold media. Proper setting of system controls is required.

Warning: The heat exchanger is not provided with safety devices against overpressure, as it is included in the piping. Therefore the risks due to overpressure must be avoided by installing suitable safety valves along the piping connected to the heat exchanger.

Filling with fluids

5.2

Caution: Fluids must be gradually introduced to the unit. Failure to do so can cause damage to the heat exchanger.

1. **Do not** admit hot fluid to the unit suddenly when empty or cold.
2. **Do not** shock the unit with cold fluid when the unit is hot.
3. **Avoid pulsation of fluids that could** cause vibrations and strains which ultimately could result in leaks.

When placing a unit in operation, open the vent connections. For this purpose, gradually open the bleed hole placed radially on each flange.

The opening in the uppermost flange is for bleeding, while the one in the lowermost flange is for system drainage, Figure 10.

The vent and drain holes are closed by two tapered threaded plugs that must be loosened only during the operation for filling the system with the fluids.

A label is fixed to the heat exchanger to indicate warning against a wrong use by unauthorized personnel of the vent and drain plugs during operation to avoid any danger due to hot fluids.

Start to circulate the cold medium only.

Be sure that the passages in the exchanger are entirely filled with cold fluids before closing the vents.

The hot medium should then be introduced gradually until all passages are filled with liquid, close vents and slowly bring the unit up to temperature.

Start operation gradually.

Retighten the bolting on all gasket joints after the heat exchanger has reached operation temperatures to prevent leaks and gasket failures. Retightening should be done uniformly and in a diametrically staggered pattern as illustrated in Figure 12 and in compliance with Section 6.6 'Bolting'.

5.3

On high pressure and high temperature applications it is recommended that the gasketed joints of the heat exchanger be retightened to the required torque after 24 hours at operating pressures and temperatures to compensate for relaxation or creep that may have occurred (refer to Table 2).

5.4

5.5 In shutting down, flow of hot medium should be shut off first. If it is necessary to stop circulation of cooling medium the circulation of hot medium should also be stopped by bypassing or otherwise. Drain all fluids when shutting down to eliminate the possibility of freezing and oxidation. To guard against waterhammer, condensate should be drained from steam heaters and similar apparatus both when starting up and when shutting down.

5.6 A heat exchanger that has, or will be, **out of service for an extended period of time** should comply with that written in Section 2 of this document.

For heat exchangers that are **out of service for short periods** and use water as the flowing medium should be thoroughly drained and blown dry with warm air, if possible. If this is not practical, the water should be circulated through the heat exchanger on a daily basis to prevent stagnant water conditions that can ultimately cause oxidation.

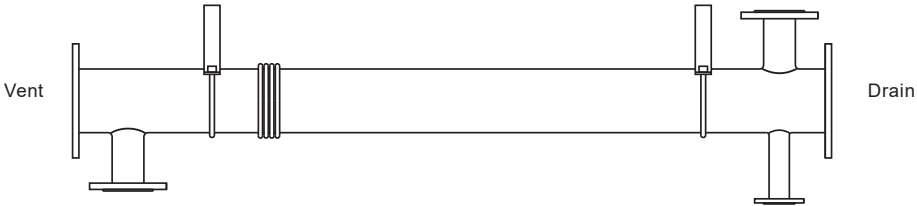


Fig. 10

Do not loosen the connection flanges until all pressure has been relieved from the equipment, the unit drained of all fluids, and the equipment surfaces cooled to ambient temperature.

6.1

Do not blow out the heat exchanger with air when fluids normally handled are inflammable.

6.2

Warning: Proper precautions must be taken (special clothing, equipment, etc.) to protect personnel from injury due to escaping fluids or hot heat exchanger surfaces.

Cleaning

6.3

Heat exchangers subject to fouling or scaling should be cleaned periodically. Sludge and scale greatly reduce heat transfer effectiveness and increase pressure drops. Since the difficulty of cleaning increases rapidly as the scale thickens or deposits increase, the interval between cleanings should not be excessive. Regularly inspect the interior and exterior surface of the tubes and keep the unit clean. This will help in preserving the performance and the mechanical integrity of the unit. Frequency of cleaning should be according to scale build-up.

Warning: Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes with consequent over-heating of these tubes, severe expansion strains and leaking tube joints.

The tube side of the heat exchanger can be inspected by sight while optical means can be used for shell side inspection.

6.3.1

Provide convenient means for frequently cleaning heat exchangers as suggested below:

6.3.2

- Circulating hot wash oil or light distillate through tubes or shell at good velocity will effectually remove sludge or other similar soft deposits.
- Soft salt deposits may be washed out by circulating hot fresh water.
- Some chemical cleaning compounds on the market may be used to advantage for removing hard scale, provided hot wash oil or water, as described above, does not give satisfactory results. Contact GESTRA for more information if required
- If the above methods are ineffective for removal of hard scale, mechanical means may be used on the tube side.

Warning:

Care must be exercised when handling certain fluids.

Follow the manufacturer instructions. Use eye and skin protection. Wear a respirator when required.

Do not attempt to clean tubes by blowing steam through individual tubes. This overheats the tube and results in tube expansion strains and sometimes leaking tube joints.

6.3.3

If scaling or other fouling were expected, connections in the piping could be provided for flushing out or chemical circulation cleaning.

6.3.4

6.4 Possible tube failure detection

At times, it may be necessary to verify the integrity of the tubes or of the joints between the tubes and the tube sheets. The following procedure is recommended.

- Remove the heat exchanger.
- Pressurize the shell side of the heat exchanger with a cold fluid, preferably water.
- Observe all tube joints and tube ends for indication of test fluid leakage.

If a leak is detected, please contact GESTRA service, an engineer will be able to support you in solving the problem.

6.5 When a heat exchanger is dismantled for any reason, before reinserting the unit into the line

- clean the gasket contact faces of the exchanger.
- replace the gaskets with new ones as indicated in Figure 11.
- accurately position the gasket before re-tightening the bolts.

Warning: gasket must always be replaced when the heat exchanger is reinstalled, re-used gaskets may provide an imperfect seal or result in damage of the gasket contact faces of the heat exchanger.

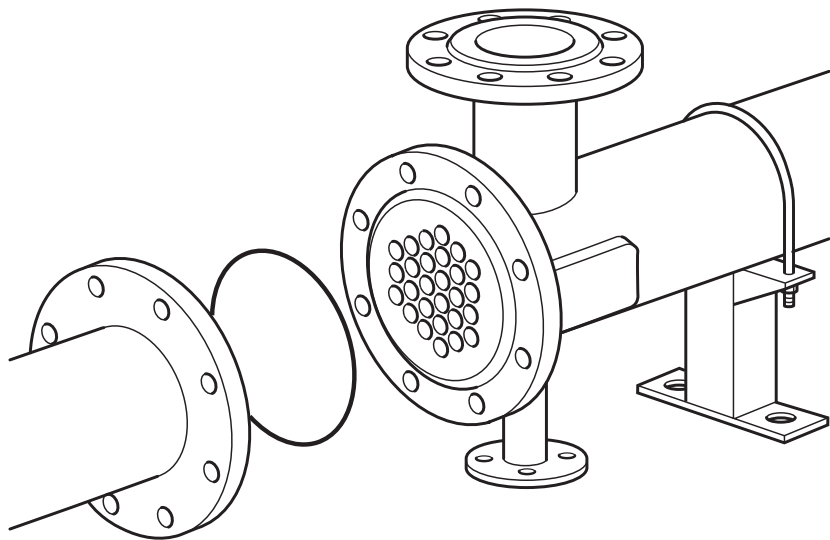
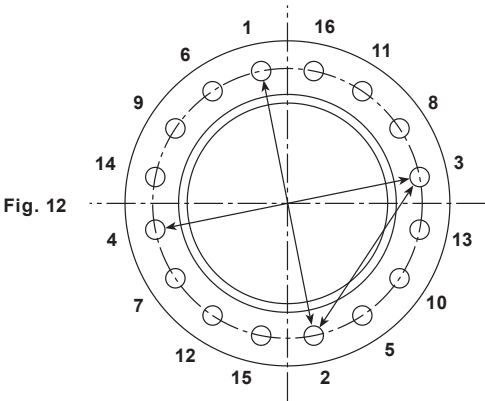


Fig. 11

Bolting

When the heat exchanger is reinstalled it is necessary to apply the torque indicated in Table 3, the values are for lubricated surfaces of bolts and studs.

The tightening must be done evenly operating on diametrically opposite bolts as illustrated in Figure 12.



Warning: It is extremely important to follow a proper tightening sequence. If this sequence is neglected, flange deformation and gasket damage are possible and this could result in leakage. Any gasket leak can result in potential injury to adjacent personnel.

It is essential that the installer follows the gasket manufacturers installation guidelines when installing gaskets. Metallic gaskets, such as the spiral wound gaskets, usually have special installation instructions. The procedure recommends that the bolts/studs be torqued in four stages.

- a. Following the staggered tightening pattern, the bolts/studs should be torqued to 1/3 of the recommended tightening torque.
- b. Same as a, the bolts/studs should be torqued to 2/3 of the recommended tightening torque.
- c. Same as a, the bolts/studs should be torqued to the recommended torque value shown in the above chart.
- d. Following the staggered tightening pattern the bolts/studs torques should be checked for equilibrium since the tightening of one bolts/studs can relieve the stress on adjacent bolts/studs.

If after following the gasket manufacturers recommended tightening procedure a leak still occurs, the bolts/studs should be tightened in the torque increments shown until the leaks stops.

Refer to section 'Commissioning' Steps 5.3 and 5.4 regarding bolt retightening after start-up.

Where frequent disassembly of the heat exchanger is encountered, the use of new bolting in conformance with dimension and specifications of the original design is recommended.

When contacting GESTRA for any issue about the heat exchanger refer to the following data stamped on the name-plate:

- Serial number
- Model
- Year

Table 3 Recommended tightening torques
for lubricated surfaces of bolts and studs

	Tube side				Shell side				
Flange	Gasket	Bolts			Flange	Gasket	Bolts		
DN	Øext./Øint [mm]	N°	Ø	Torque [N m]	DN	Øext./Øint [mm]	N°	Ø	Torque [N m]
40	63/43	4	M16	131	32	78/58	4	M16	102
					15	45/25	4	M12	42
50	78/58	4	M16	134	40	63/43	4	M16	107
					15	45/25	4	M12	42
80	111/91	8	M16	111	65	122/102	8	M16	110
					15	45/25	4	M12	42
100	140/120	8	M16	115	80	111/91	8	M16	93
					25	68/48	4	M16	68
150	192/172	8	M20	216	100	140/120	8	M16	115
					25	68/48	4	M16	68
200	258/238	12	M20	184	125	171/151	8	M16	122
					32	78/58	4	M16	102
250	312/292	12	M24	247	150	192/172	8	M20	187
					40	63/43	4	M16	107
Coupling according to EN1092-1 PN16 with bolts in ASTM A193 Gr.B7 e Gr.B8 Cl.1									
Gasket in graphite reinforced with stainless steel, 2 mm thickness (m = 2, Y = 17 N/mm²)									

LOSS OF GUARANTEE

Total or partial disregard of above instructions involves loss of any right to guarantee.



Agencies all over the world: **www.gestra.com**

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