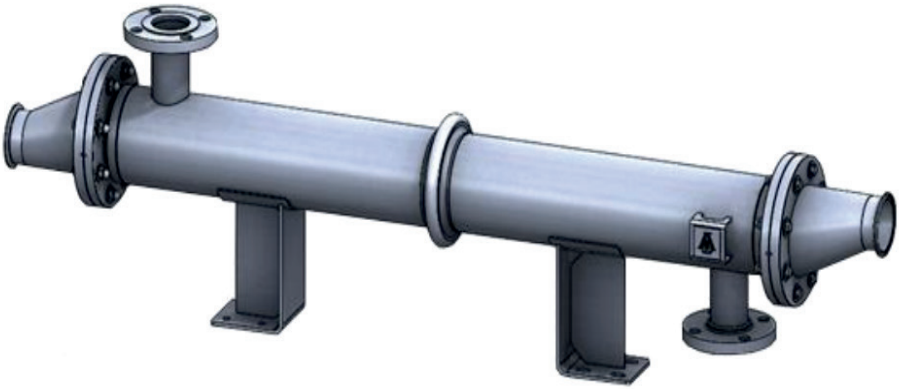
P-Line heat exchanger

Installation and Maintenance Instructions



1. Safety information

Safe operation of these products can only be guaranteed if they are properly installed, commissioned, used and maintained by qualified personnel 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.

Before proceeding to the installation and launch of the pressure vessel, read the manual.

This manual contains basic safety rules, which should be complied during installation, activation and operations of pressure vessel. Staff involved in assembly and operations workers are obligated to familiarize themselves to this manual and related instructions of components before activation and operation.

Operation or service workers of this pressure vessel have to have adequate qualifications. The area of their responsibilities and competences must be completely controlled by client. If staff is not qualified, they need to be trained and instructed. The customer should also make sure that staff understand the content of this manual.

1.1. General safety work requirements

General requirements for safety operations are covered by national standards, that in details define rules of operations of this kind of device. Additionally, regulations of fire safety and protection against electric shock should be considered.
In any case it is necessary to:

- **Eliminate leaks of working medium, because it poses direct danger to operators. The areas of leaks should be protected. In case of leaks In pressure installations, they must be removed by tightening screws or fasteners. These actions are permitted only when there is no pressure in the system;**
- **Take care of the order within reach of the pressure vessel, especially during service work e.g. remove split working medium, even if it is a small amount or even single drops;**
- **Eliminate risk of the electric shock. Electrical connection of the measuring/ control equipment should be performed by qualified personnel. The customer have to get known with local safety regulations;**
- **During the assembly work, switch off all of a electric al equipment and hang up a warning board that will prevent accidental activation;**
- **Optional welding of pipes to pressure vessel perform only after cleaning, drying and thorough ventilation;**
- **The place in which pressure vessel is located should be equipped with efficient ventilation and fire-fighting equipment;**
- **Before opening the pressure vessel, costumer need to balance pressure between the tank and environment.**

1.2 Dangers resulting of not following instruction manual

Failure to follow these instructions poses risks to the safety of personnel operating the pressure equipment and the environment. Any failure to follow this instruction may result in loss of warranty and loss of service.

1.3 Unauthorised modifications and adaption

All modifications and adaption have to be made by the manufacturer of the pressure vessel.

2. General product information

P-line heat exchangers meet the highest requirements of the pharmaceutical industry. At the same time, they meet its stringent hygiene standards imposed by inspection bodies. They have been designed to minimize the risk of contamination and to ensure safe and sterile work. Tubes are connected to the tube sheets with pressure expanding method in which clean water under pressure up to 6000 bar is used. This eliminates the risk of damaging the internal surface of the tubes. Stainless straight tubes with a diameter of 8 mm (0.315") or 12.7 mm (0.5").

Certified Viton gaskets and triclamps, the clean side connections, in compliance with 3-A and American Food and Drug Administration FDA. Expanded tubes are then welded to the external tube sheet with orbital using welding a pure argon shield method.

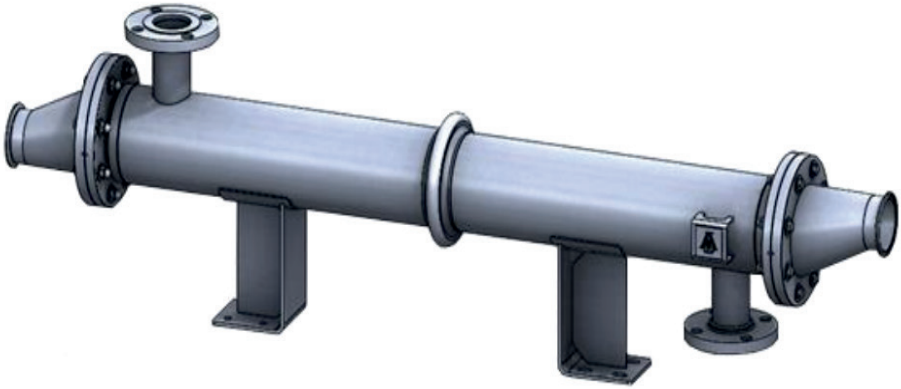


Fig. 1

3. Transport

- Lifting equipment must be used for loading and unloading the pressure equipment (with saving safety regulations);
- Before transporting/ disassembling, the pressure vessel need to be drain, all of connections should be covered and all components that can be damage during transporting/ disassembling should be protected;
- During transport, pressure vessel have to be property set and secured to eliminate possibility of moving;
- Lifting belts should be made from soft material, in order to avoid damage (eg scratches) on the external surface of the exchanger;
- Do not use nozzles to lift the exchanger;
- In case of horizontal heat exchanger do not use mounting for lifting.

After transporting, it is necessary to check the condition of the heat exchanger.

The damage and defects observed must be reported immediately to the producer.

4. Storage

The pressure vessel should be strictly stored in a closed warehouse, protected from external corrosion factor and dust. No active substances may be stored in the same store;

- Inside temperature should be within the range of 5 °C to 30 °C [of 41 °F to 86 °F] and air relative humidity from 50% to 80%;
- During storage all connections should be plugged.

5. Installation and assembly

5.1 General requirements

- Before assembly, external and internal surfaces of pressure vessel have to be inspected to ensure that there is no damage caused by shipping or storage;
- Before assembly, check the documentation of the building where pressure vessel will be installed, and check that the installation does not affect the permissible loads for the building;
- The location of the pressure vessel should provide convenient access, safe operation, ventilation and lightening;
- Installation of the heat exchanger is based on its foundation. Once the heat exchanger is attached, the piping must be connected;
- During assembly, remove all plugs that secure connections during shipment and storage;
- During assembly ensure the required degree of cleanliness of the joints;
- Assembly action should be carried out at ambient temperature not lower than 0 °C [32 °F].
- Piping used in the connection system need to be clean – free from rust, burrs, filings, welding sprays and greases;
- Pipes should be connected in a way that eliminate mechanical stress;
- When attaching the valves, take note of their weight;
- Piping should be supported if needed;
- Due to the thermal stresses caused by temperature changes in long pipelines, the pipe handles must be tightened to allow their longitudinal movement due to temperature changes;
- It is not allowed to weld connection pipes directly to the support elements;
- Electrical connection to control and measure equipment have to be made by qualified personnel in accordance with the manufacturer's electrical scheme;
- After assembly make sure that no tools or other objects was left in pipes or in pressure vessel.

The installation must be equipped with devices protecting against destroying or damaging the heat exchanger, in particular against pressure and temperature rises and drops, hydraulic shocks and impurities.

Temporary increase of pressure during work of safety device cannot be greater than 10%.

5.2. Mounting positions

Device has to be installed in accordance with letter symbol included in the name of heat exchanger:

- letter H (P/S-XXX.XXX.XX.H-XP.X) means that heat exchanger should be mounted in horizontal position,
- letter V (P/S-XXX.XXX.XX.V-XP.X) means that heat exchanger should be mounted in vertical position.

Horizontal position assembly

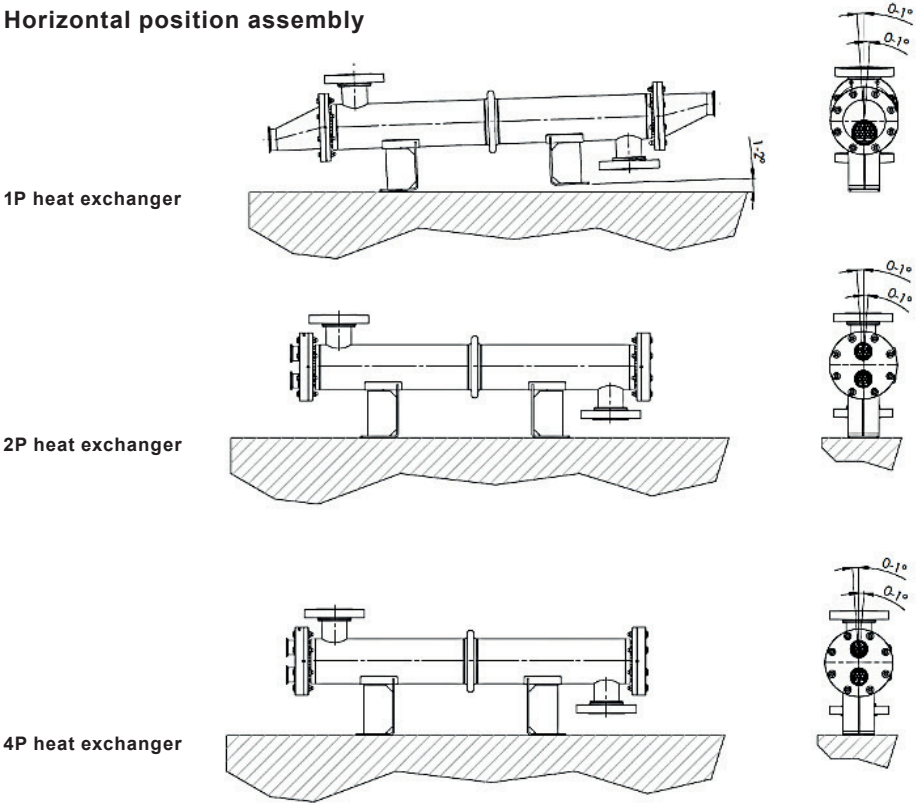
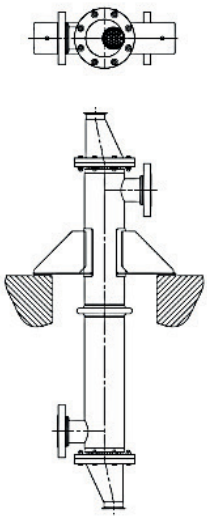
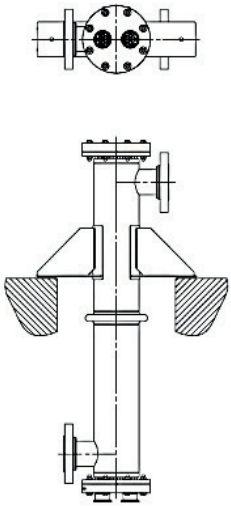


Fig. 2

Vertical position assembly



1P heat exchanger



2P heat exchanger

Fig. 3

5.3. Drain-ability

P-Line heat exchangers are designed as drainable on the tubes side (sanitary side) and crevice free. In order to provide that requirement heat exchanger has to be assembled in accordance to the plan shown on a drawing. Different assembly positions can be done after consultation with the manufacturer.

- 1P type heat exchangers assembled either in horizontal or vertical position are fully drainable,
- 2P type heat exchangers assembled in vertical position are fully drainable,
- 2P and 4P type heat exchangers assembled in horizontal positions needs air or nitrogen purging to remove remaining mediums.

4P type exchangers can only be installed in a horizontal position.

5.4. Fixing to the base

▪ horizontal position assembly - support leg feet with drilled round holes should be treated as a fixed bracket, support leg feet with machined slots should be treated as a movable bracket (not fixed to the base) (Fig. 4),
▪ vertical position assembly – there should be provided minimum 102 mm clearance between the outside of the tubular heat exchanger and the wall or a column (Fig. 5).

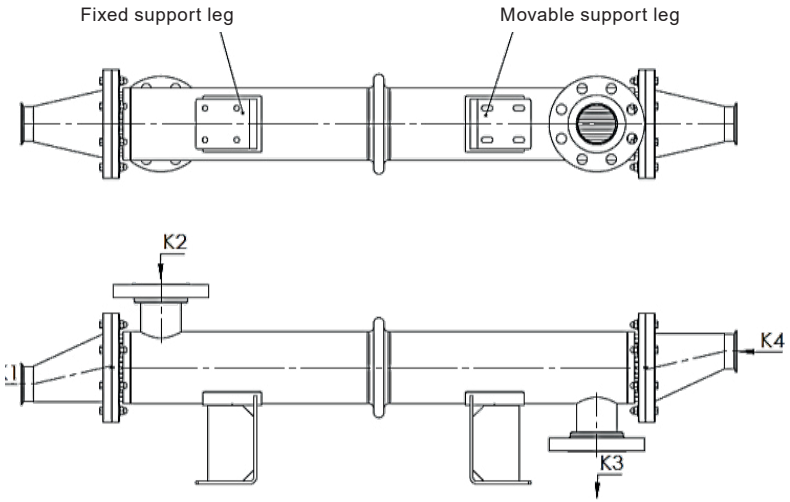


Fig. 4

Gaskets must be placed between heat exchanger bracket foot and base. Gasket material: NBR or EPDM, gasket thickness: 1-2 mm.

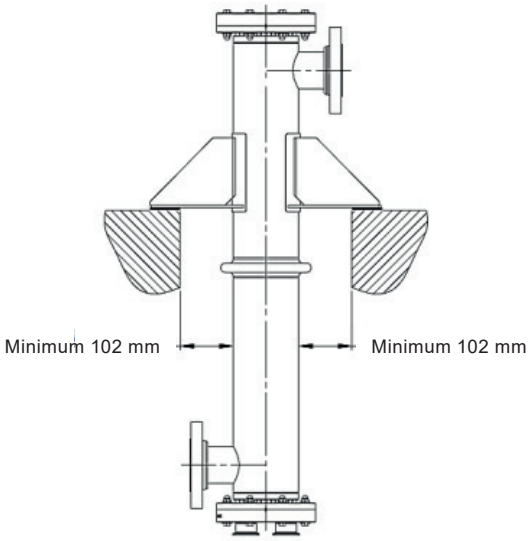
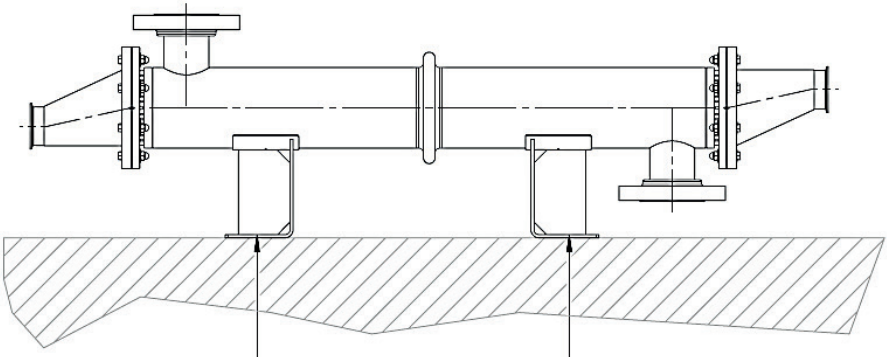


Fig. 5



Gasket
Adjust gasket size to feet dimensions

Gasket
Adjust gasket size to feet dimensions

Fig. 6

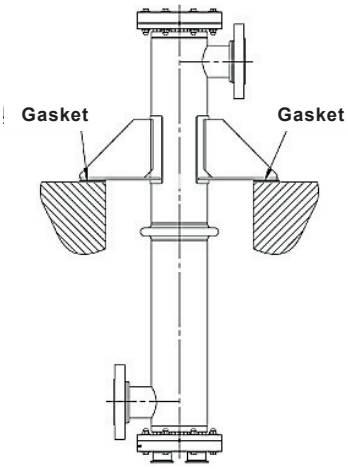


Fig. 7

6. Intended use

P-line and S-Line heat exchangers are addressed for the pharmaceutical and food industry and all applications where a high hygienic standard devices are needed. Examples of implementation in the industry are:

- Pharmaceutical industry
  - pure steam
  - blood, plasma or media growth
  - water for injection
  - process equipment
- Food & dairy industry
  - evaporation such as sugar concentration
  - juice, sauce, oil and syrups
  - brewery processes
  - chocolate and similar viscous products
  - pasteurization

7. Construction

7.1. General information

P-line heat exchangers are designed to meet high hygienic demands. Shell side is a standard construction of shell and tube heat exchanger. The tube side (sanitary side) is designed for contact with sanitary products, the internal surfaces are made with the following roughness values::

▪ P-line heat exchangers - Ra≤0,5µm,

Heat transfer area is created by straight tubes OD8x1mm or OD12,7x1,65mm manufactured in accordance with ASTM A-270. On both ends tubes are ended with external flanged tubesheet. Depends on heads set attached to that tubesheet 1, 2 or 4 passes heat exchanger can be gained. P-line heat exchangers can be installed in horizontal or vertical positions and work as a direct or counter current flow devices. Double tubesheet constructions protects against mixing sanitary side fluid with shell side fluid (dirt side) in case of leakage and also makes leakages easier to be detected.

Materials used for manufacturing P-line heat exchangers are in accordance with FDA and 3A requirements. Sanitary gasket meets the requirements of 3-A 18-03 standard. The pressure test was carried out with demineralized water. Device is designed acc. to sanitary standard 3-A:

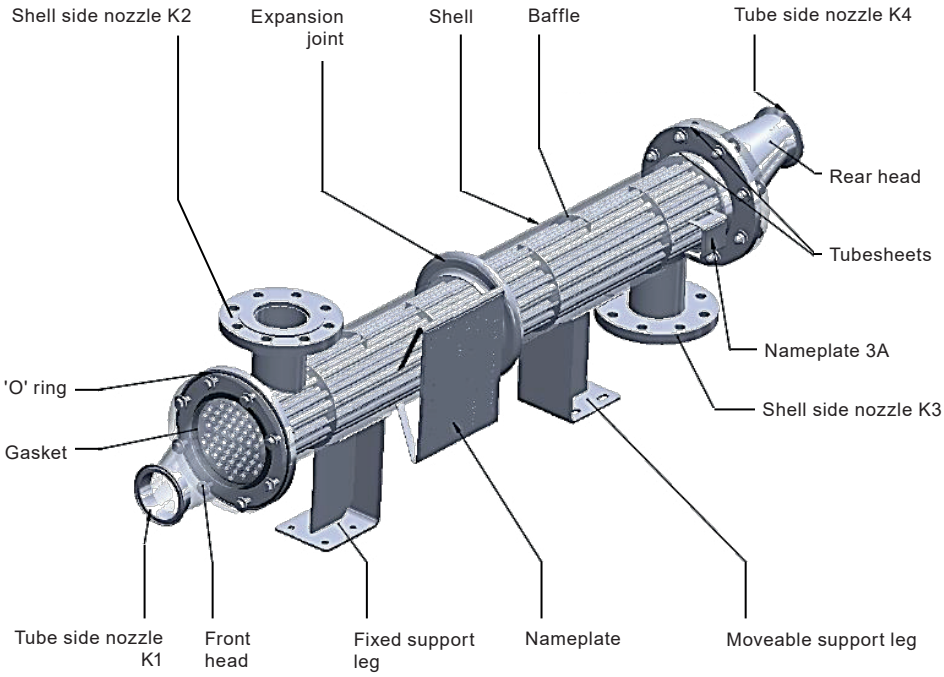


Fig. 8 Heat exchanger 1P acc. to / wg EN 13445

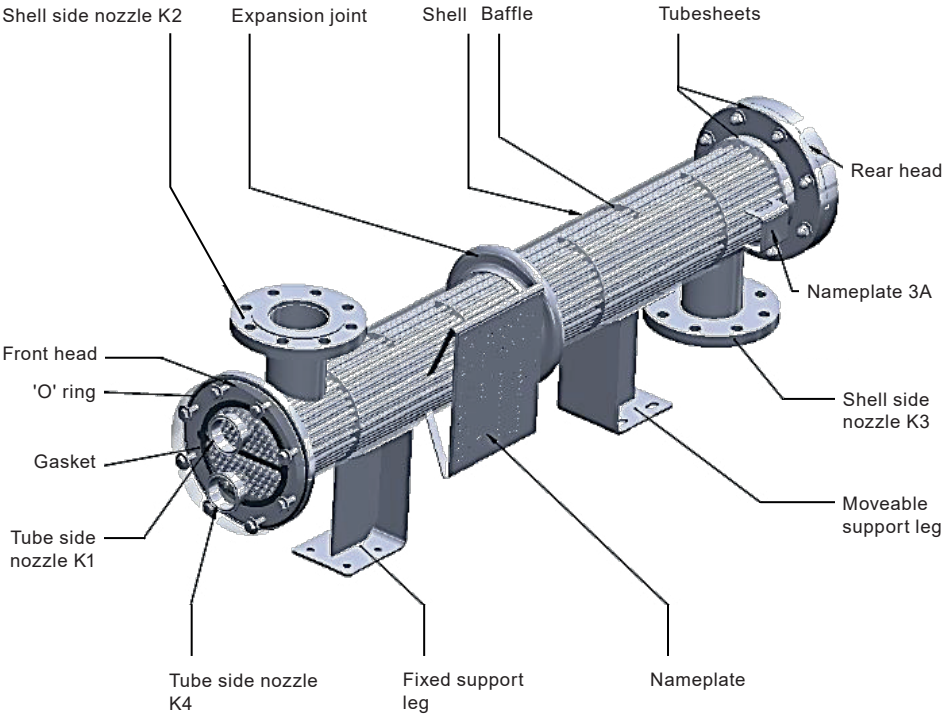


Fig. 9 Heat exchanger 2P/4P acc. to / wg EN 13445

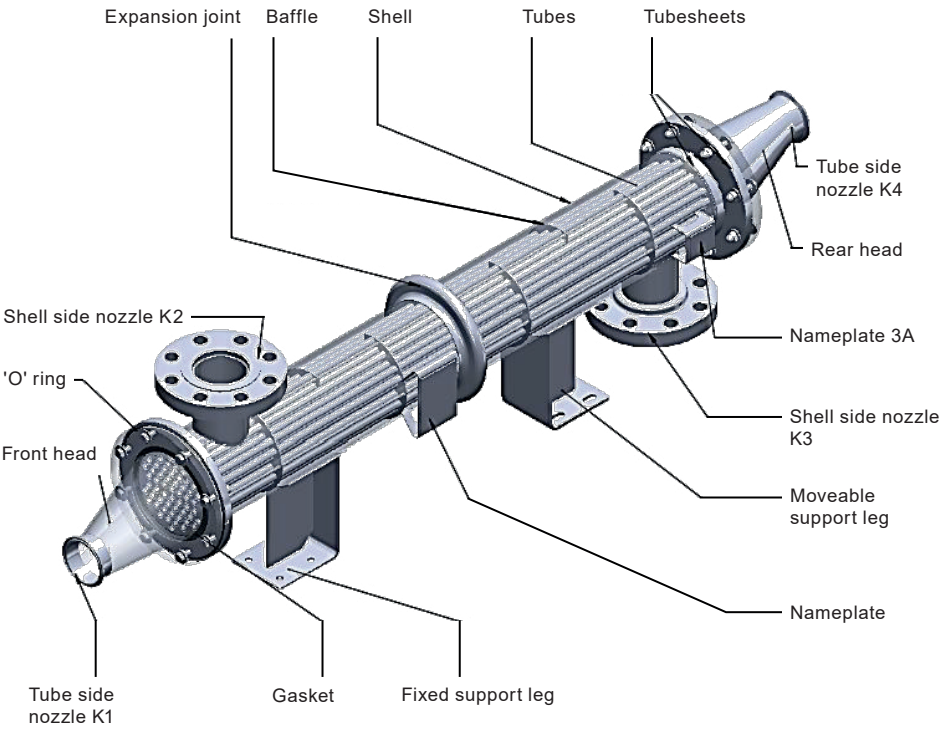


Fig. 10 Heat exchanger 1P acc. to / wg ASME BPVC SEC VIII DIV 1

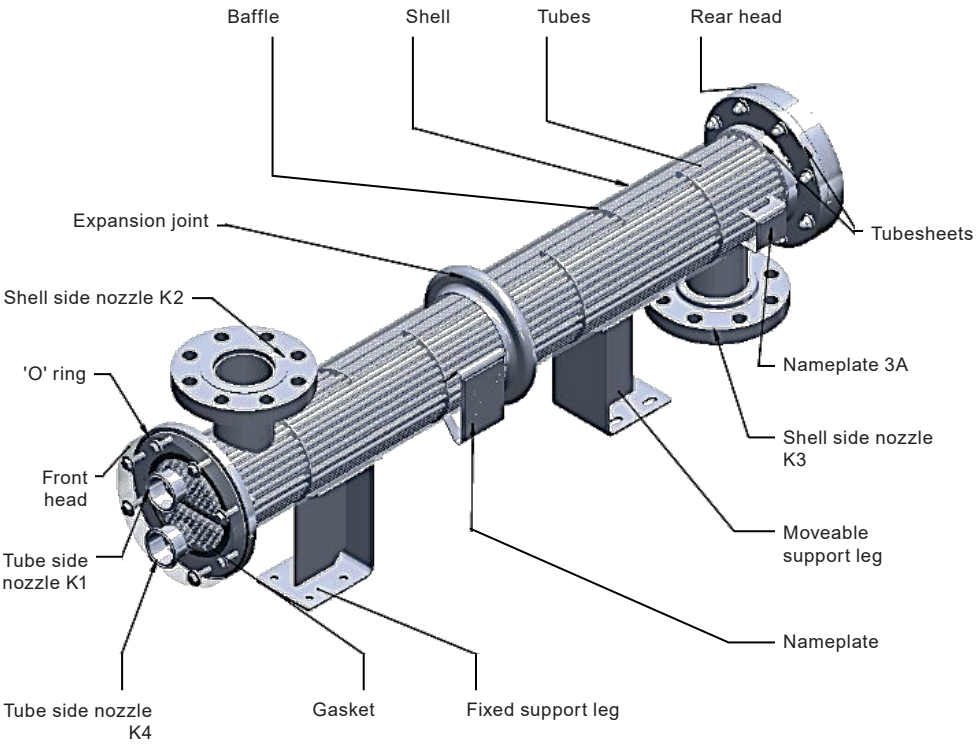


Fig. 11 Heat exchanger 2P/4P acc. to / wg ASME BPVC SEC VIII DIV 1

7.2. Materials

P-line heat exchangers are manufactured from austenitic stainless steel.

For heat exchangers acc. to EN 13445:

- tube side (sanitary side) material – 1.4404 (316L),
- shell side material – 1.4404/1.4307 (316L/304L).

For heat exchangers acc. to ASME BPVC SEC VIII DIV 1:

- tube side (sanitary side) material – 316L,
- shell side material – 316L/304L.

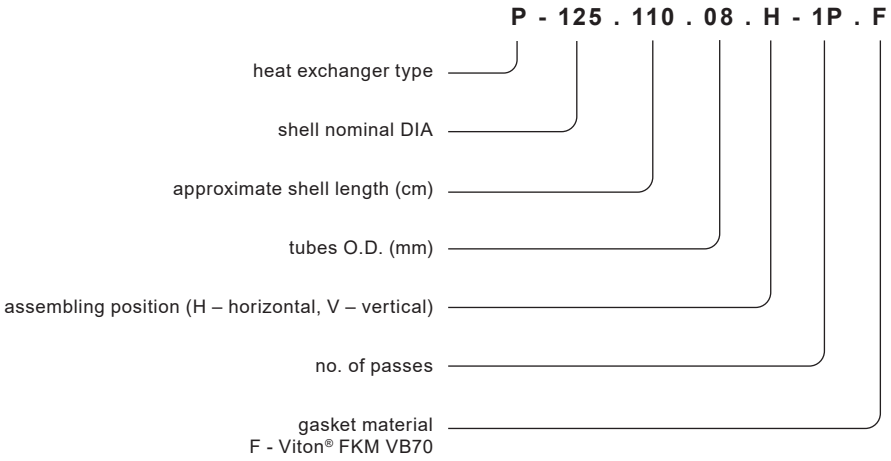
Sanitary side connections are in accordance with ASME BPE or DIN 32676 and 3-A 63-03, depending on type of heat exchanger.

Gasket in contact with sanitary side are machined from Fluoroelastomer (FKM-Viton). Materials used for production are in accordance with US FDA Rubber 21CFR170/199 2600 Regs, USP Class VI and USP MEM Elution Cytotoxicity, EU 1935/2004(3)EC Food Contact Regs excluding Organoleptic (Sensory) testing.

Letter in the marking	Heat exchanger	Gasket material	Maximum allowable temperature		Minimum allowable temperature	
			[°C]	[°F]	[°C]	[°F]
F	P/S-XXX.XXX.XX.X-1P.F	Viton FKM VB70	140	284	-17	1,4

Table 1 Temperature range for gasket material

8. Heat exchangers marking



9. First start-up

Before starting the station containing the heat exchanger, check:

- completeness and technical condition of the heat exchanger,
- correctness of electrical connections of control and measurement equipment,
- correctness of grounding.

10. Operation

10.1 General requirements

In order to provide proper heat exchanger operation following rules should be obeyed:

- care should be taken to ensure that heat exchanger is installed correctly,
- do not operate heat exchanger under conditions that exceeds parameters specified on the name plate,
- start all operations gradually (suggested temperature increment no more than 10 °C/min [50 °F/min], pressure increment no more than 3 bar/min [43,5 psi/min]),
- do not allow rapid temperature changes, if not temperature shock can be caused,
- during start up procedure, cold side fluid circuit should be turn on first,
- during shut down procedure, hot side fluid circuit should be cut off first,
- when heat exchanger is in operation, work pressure on tube side (sanitary side) must be higher than work pressure on shell side,
- media flow should be characterized by the lowest pulsation caused by operating pump, pulsations can cause vibrations and straining that could result in leaks,
- heat exchanger should be checked for fouling at regular intervals (checking e.g. leakage, pollution level etc.),
- when heat exchanger is not in operation, tube and shell side should be empty from working medium.

10.2. Cleaning

The P-Line type heat exchangers have been designed for cleaning in the CIP system. The minimum flow rate of the cleaning agent for a given type of exchanger is given in Table 1. Pressure and temperature can not exceed the maximum parameters of the exchanger's operation parameters. The flow velocity in the pipe at CIP should be V=1.5-2.1 m/s to 3 m/s [V=4,9-6,9 ft/s to 9,8 ft/s], the flow should be turbulent.

Heat exchanger	Minimum Medium FLOW Q					
	[m³/h]			[ft³/h]		
	Head type					
	1P	2P	4P	1P	2P	4P
P-050.XXX.08.X-1P	2.9	-------	-------	102.4	-------	-------
P-050.XXX.12.X-1P	2.6	-------	-------	91.8	-------	-------
P-080.XXX.08.X-1P.X	4.9	-------	-------	173.0	-------	-------
P-080.XXX.12.X-1P.X	7.1	-------	-------	250.7	-------	-------
P-100.XXX.08.X-1P.X	8.2	-------	-------	289.6	-------	-------
P-100.XXX.12.X-1P.X	9.7	-------	-------	342.6	-------	-------
P-125.XXX.08.X-XP.X	12.5	6.3	-------	441.4	222.5	-------
P-125.XXX.12.X-XP.X	16.5	8.2	-------	582.7	289.6	-------
P-150.XXX.08.X-XP.X	18.3	9.2	-------	646.3	324.9	-------
P-150.XXX.12.X-XP.X	20.2	10.1	-------	713.4	356.7	-------
P-200.XXX.08.X-XP.X	26.9	13.4	6.7	950.0	473.2	236.6
P-200.XXX.12.X-XP.X	36	18	9	1271.3	635.7	317.8
P-250.XXX.08.X-XP.X	49.8	24.9	12.5	1758.7	879.3	441.4
P-250.XXX.12.X-XP.X	69	34.5	17.2	2436.7	1218.4	607.4

Table 2 Parameters for the tubes side for CIP cleaning

During cleaning, the exchanger's operating parameters can not be exceeded.

Time and temperature * at the CIP cleaning process						
Process	Time		Temperature			
	min.	max.	min.	max.	min.	max.
	[min]		[°C]		[°F]	
pre-rinsing (water)	5	20	40	60	104	140
corrosive detergent (alkalis)	20	45	50	85	122	185
rinsing (water)	5	15	45	75	113	167
acid detergent	20	30	-	65 (suggested / 50)	-	149 (suggested / 122)
rinsing (water)	15	20	30	60	86	140
decontamination	5	10	5	25	41	77

* parameters shown in table above are for information only, each CIP process should be design to fulfill the requirements of the installation under the cleaning process

Table 3 Typical CIP process

Examples of cleaning agents		Gasket material - Viton FKM
alkali normal level of use 0,1-2%	sodium hydroxide	not recommended (up to 2% of the volume)
	sodium carbonate	YES
	sodium metasilicate	YES
	sodium hypochlorite	YES
	trisodium phosphate	YES
acids normal level of use 0,1-2%	nitric acid	YES
	phosphoric acid	YES

Table 4 Gasket material compatibility with basic cleaning agents

When designing the CIP process, corrosive properties of cleaning mediums should be taken into account, their influence on heat exchanger base material and gaskets.

If gas purging is necessary (see pt 4.3.) the gas used must be prepared in accordance with the 3-A sanitary standard. If nitrogen is used, it must be intended for use in the food industry.
Gas feeding should be done via nozzle (see Annex A or E):

- K1 or K4 for 1 pass heat exchangers
- K1 for 2 and 4 pass heat exchangers

The exchanger heads are easily disassembled to allow manual cleaning of internal surfaces and inspection. P-line and S-Line heat exchangers can be also sterilized by saturated steam or water under pressure – see information label for maximum temperature and pressure conditions.

During heads assembling or disassembling, an extra care should be taken not to damage surfaces in contact with sanitary side like: internal heads surface, gasket recessed grove or external tubesheet surface.

10.3 Gaskets

P-line heat exchangers are equipped with two kind of gaskets:

- flat gasket (sanitary gasket) positioned in the recessed gasket grove machined in head flange,
- O-ring that protects from dust getting into the gap between tube sheet and head flange, gasket is positioned in external tube sheet grove.

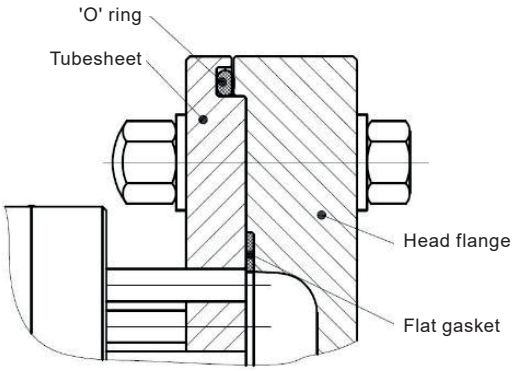


Fig. 12

Depends on assembled heads set type three different sets of flat gaskets can be differed (sanitary gaskets).

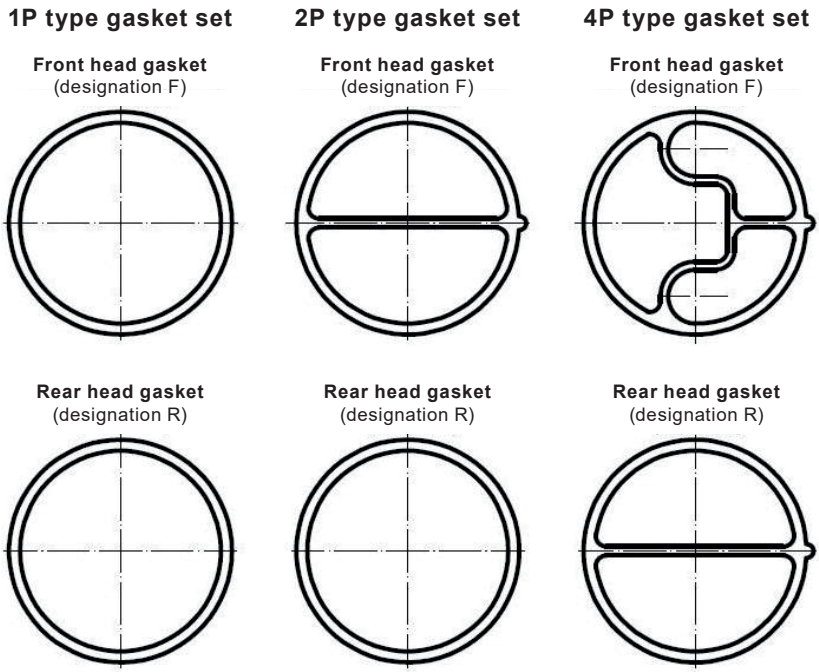


Fig. 13

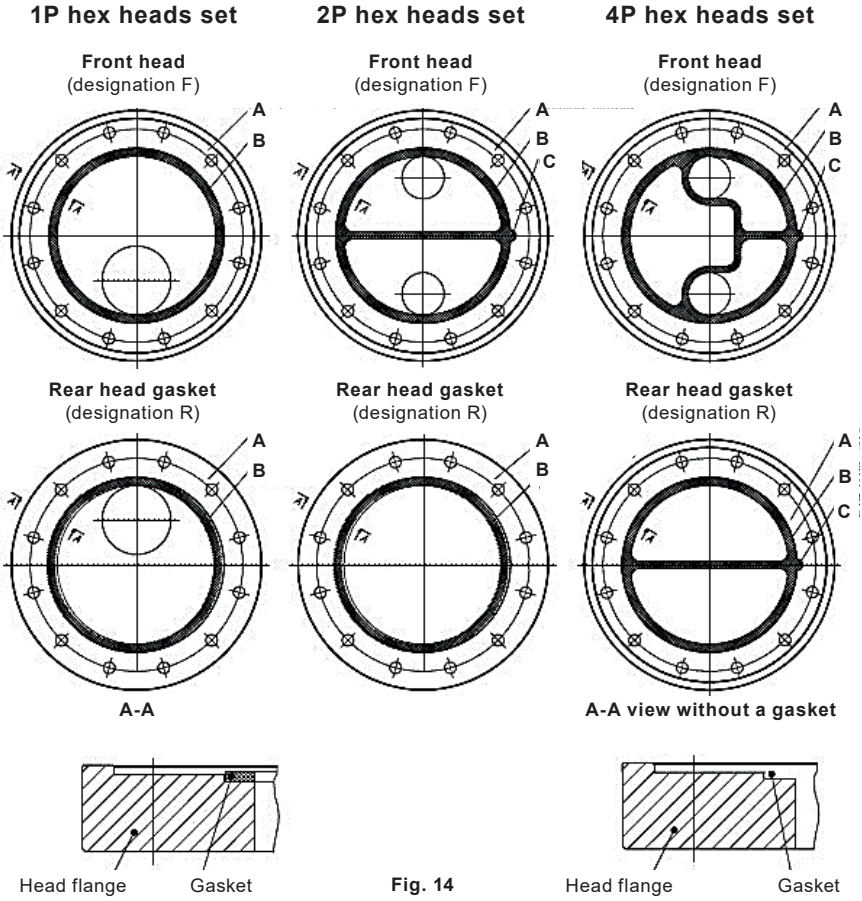


Fig. 14

- It is recommended, to reassemble new set of sanitary gaskets when heat exchanger is dismantled.
- Extra care should be taken no to damage recessed gasket grove machined in head and also gasket surface, avoid scratches etc.
- Before heads reassembling an attention should be paid to provide correct positioning of the flat gasket (sanitary gasket) in head gasket recessed grove. Gasket should seat flat in the grove (Fig. 14).
- Care should be taken not to damage (scratch, pits etc.) flat (sanitary) gasket sealing surface.
- 2P and 4P gasket has got an inset that should match the same shape inset that is machined in 2P and 4P heads flange gasket grove (for 2P, 4P front head and 4P rear head). That allows to position correctly the gasket against head partitions (Fig. 14).
- O-ring should be replaced in case of damaging of external surface or gasket brake etc.

10.4 Head assembly

In order to provide correct location of the head against tubesheet and heads against shell, there are machined marking grove on tubesheets and heads flanges, there is also a letter symbol stamped on each tubesheet and head. Letter symbols on the heads (side face of the flange):

- F – front head,
- R – rear head.

Correct way of heads assembling shown below.

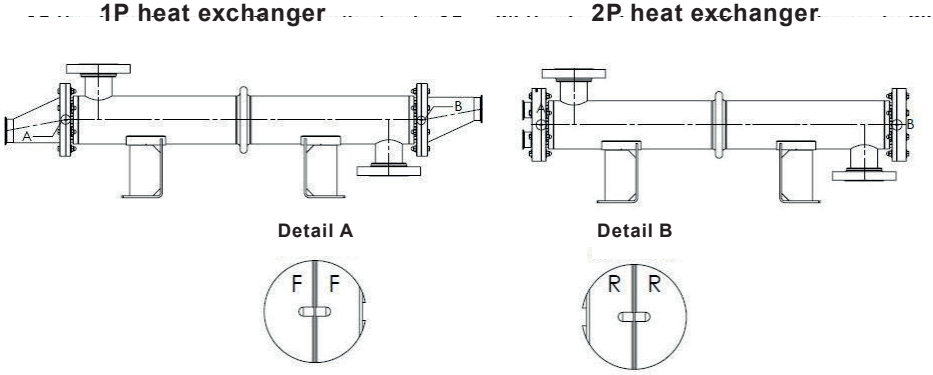


Fig. 15

During assembling or disassembling of heads, an extra care should be taken not to damage surfaces in contact with sanitary side like: internal heads surface, gasket grove or external tubesheet surface.

10.4.1 Bolting connections

Between the pressure test carried out by the manufacturer and the installation of the heat exchanger there may be a leakage in the sealed connections. All screw connections must be evenly tightened before starting the installation. The tightening sequence is shown in the figures below (depending on the number of bolts). The tightening torque is given in Table 3.

Heat exchanger	Tightening torque per screw acc. to: / wg:	
	ASME BPVC Sec.VIII, Div. 1	EN 13445
	[Nm]	
P/S-050.XXX.XX.X-XP	-	-
P/S-080.XXX.XX.X-XP.X	35	20
P/S-100.XXX.XX.X-XP.X	38	20
P/S-125.XXX.XX.X-XP.X	15	20
P/S-150.XXX.XX.X-XP.X	15	20
P/S-200.XXX.XX.X-XP.X	20	20
P/S-250.XXX.XX.X-XP.X	25	20

Table 3 Tightening torques

11. Standard checklist

11.1 Routine checks:

- control of the measuring devices.

11.2 Periodic control include:

- tightness control of piping and connections,
- keep outside surfaces clean if the machine is operating in a dusty environment. In good condition keep the built-in control and measurement equipment cool and eliminate the possibility of self-ignition of dust,

Malfunctions or damage to the pressure equipment can be caused by:

- leaks,
- pressure drops.

Any interventions should be noted.

The control and service activities of the built-in control and measurement apparatus are described in the individual instructions of each component.

The sealing elements of the joints are aging and should be replaced periodically according to the manufacturer's instructions.

12. Technical specification

The heat exchanger can work only for mentioned parameters.

It is unacceptable to change the purpose of work of heat exchanger.

Technical specification for heat exchangers acc. to ASME BPVC Sec.VIII, Div. 1 given in Annex A.

Technical specification for heat exchangers acc. to EN 13445 given in Annex E.