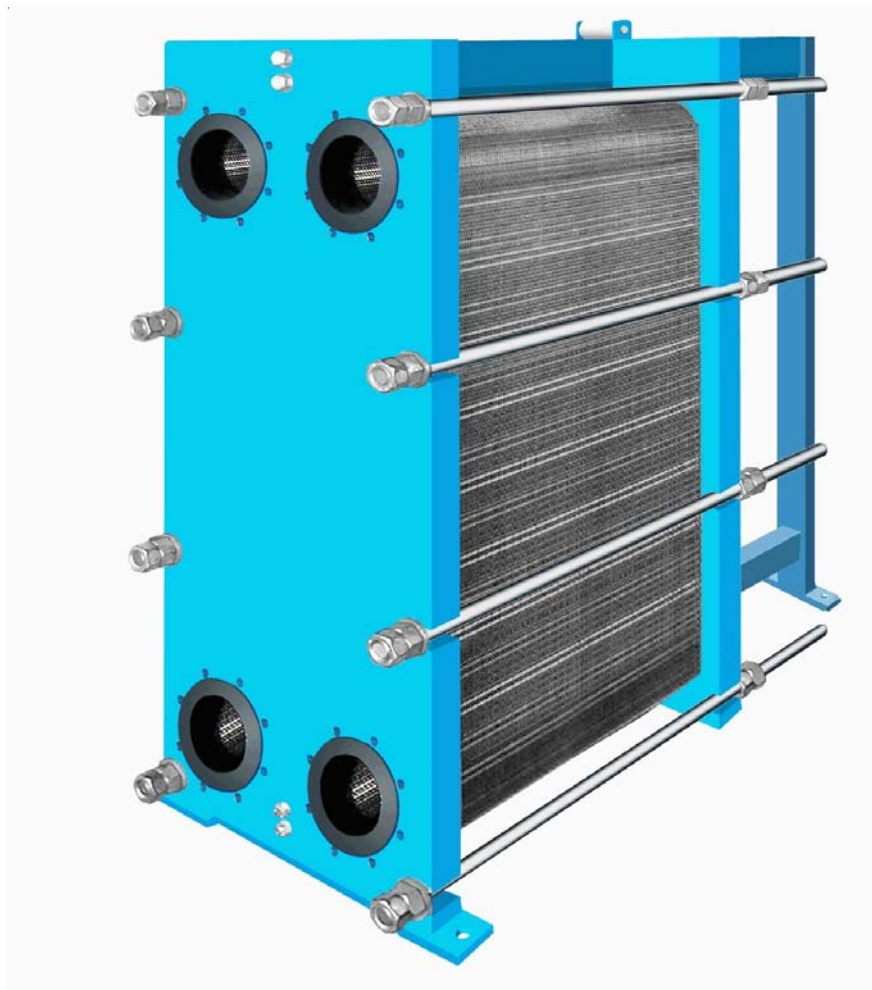


# Plate heat exchanger series FP, FPS, FPG, FPSF, FPSS




General view (FP series)

Edition 2003 / 10

## Operating instruction

## Table of contents

<b>1.0 General</b>	
1.1 User information.....	S.2
1.2 Intended use.....	S.3
1.3 Identification/name plate.....	S.3
<b>2.0 Safety instructions</b> 	S.4
<b>3.0 Functional description</b>	
3.1 Design - main components.....	S.4
3.2 Function specification/graphical presentation.....	S.5
3.3 Special feature of FPG and FPSS series.....	S.5
3.4 Connection position single pass/multi pass.....	S.6
<b>4.0 Transport und Installation</b>	
4.1 Transport handling and assembly.....	S.6
4.2 Space requirement/minimum distance.....	S.7
4.3 Ambient conditions.....	S.7
4.4 Pipe assembly.....	S.8
<b>5.0 Operating instruction</b>	
5.1 Initial operation.....	S.8
5.2 Start up.....	S.8
5.3 Operation.....	S.9
5.4 Shut down.....	S.9
<b>6.0 Maintenance</b>	
6.1 Basic instructions for maintenance.....	S.9
6.2 Shut-down and opening of PHE.....	S.10
6.3 Cleaning of plates.....	S.11
6.4 Replacement of plates and gaskets.....	S.12
6.5 Closing and tightening of PHE.....	S.13
6.6 General maintenance work.....	S.14
<b>7.0 Troubleshooting / removal of faults.....</b>	<b>S.15</b>

## 1.0 General

### Name and address of manufacturer:

FUNKE WÄRMEAUSTAUSCHER APPARATEBAU GmbH

Zur Dessel 1, D-31028 Gronau/Leine

Fone: +49 (0) 5182 582-0, Telefax: +49 (0) 5182 582-48

e-Mail: info@funke.de, Internet: www.funke.de

### 1.1 User information

These instructions refer to standard design of FUNKE plate heat exchangers (PHE).

Special designs may require supplementary operating and maintenance instructions. Please always follow the specifications related to the respective purchase order!

Only qualified personnel have to carry out operating and maintenance of PHE.

National and international rules concerning pressure equipment, dangerous liquids and gases as well as accident prevention and operational safety are to be complied with.

(In Germany: safety law and appropriate regulations)

**Chapters where operating methods and instructions must be strictly complied with in order to avoid any danger to persons or system damage, are marked with a warning triangle (shown below):**



**Chapters where operating methods, operating conditions and maintenance instructions must be strictly complied with to guarantee faultless function of the PHE as well as efficient operation, are marked with the following sign:**



**Before** starting work the personnel must be instructed by the user. The operating instruction must always be available. If the required work is not mentioned in these instructions or if any instructions are not understood, FUNKE shall be contacted **before** starting work.

## 1.2 Intended use

FUNKE PHE are designed for special conditions of use specified by the customer, concerning temperature, pressure, volumetric flow and flow media and are fabricated in conformity with EC-PED 97/23, except where customers order specifications dictate otherwise.

In the event of any change in design or operation from the order specification, written approval by FUNKE is necessary, to avoid affecting the warranty/liability terms and conditions.

Heavy pressure surges or hydraulic shocks may cause mechanical damage or material damage and must be avoided all cases!!!


## 1.3 Identification / name plate

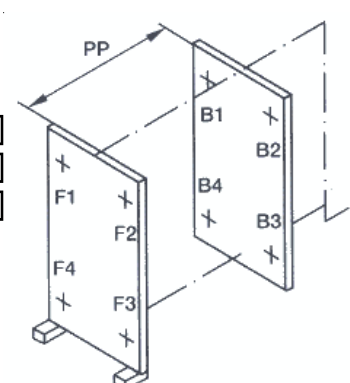
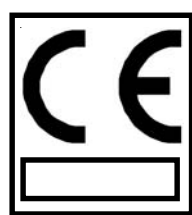
Each FUNKE PHE is provided with a nameplate, placed on the outside of the fixed plate. The plate showing the following data, must always be accessible and recognisable:

- **PHE type / series**
- **Serial number** (to be stated on all enquiries)
- **Construction year**
- **Max. working pressure** (page 1/page 2)
- **Test pressure** (page 1/page 2)
- **Max. operating temperature** (page 1/ page 2)
- **Volume** ( page 1 / page 2)
- **Fluid group** (acc. to EC PED 97/23/EG)
- **CE-code** (if required)
- **Identification no. of "certified body"** acc. to PED
- **Test date**
- **Position of connections** (page 1 / page 2)
- **Compression dimensions "PP"-max.**
- **Compression dimensions "PP"-min.**
- **Extra space** (for instance for "min. operating temperature")

Basic structure of a name plate:  
(also 2 parts possible)

Figure 1



Typ/Type	<input style="width: 100%;" type="text"/>	
Serien-Nr./Serial-No.	<input style="width: 100%;" type="text"/>	
Zeichnung-Nr. / Drawing-No.	<input style="width: 100%;" type="text"/>	
	Warme Seite Warm side	Kalte Seite Cold side
PS max.	bar	<input style="width: 100%;" type="text"/>
TS min.	°C	<input style="width: 100%;" type="text"/>
TS max.	°C	<input style="width: 100%;" type="text"/>
V	l	<input style="width: 100%;" type="text"/>
PT	bar	<input style="width: 100%;" type="text"/>
Fluidgruppe / Fluidgroup	<input style="width: 100%;" type="text"/>	<input style="width: 100%;" type="text"/>
Anschl. / connections	<input style="width: 100%;" type="text"/>	<input style="width: 100%;" type="text"/>
Ein-Aus / in-out	<input style="width: 100%;" type="text"/>	<input style="width: 100%;" type="text"/>
Anspannmaß „PP“ Compression length		
max.	<input style="width: 100%;" type="text"/>	
min.	<input style="width: 100%;" type="text"/>	
Baujahr/ Year of construction	<input style="width: 100%;" type="text"/>	
		
		Prüfdatum Test date <input style="width: 100%;" type="text"/>
Funke Wärmeaustauscher Apparatebau GmbH, D-31028 Gronau / Leine		

## 2.0 Basic safety instructions



Plate heat exchangers (PHE) are pressure-containing equipment and shall be connected, operated and maintained only by qualified personnel! National and international directives for pressure equipment (Europe: EC PED 97/23/EG), dangerous liquids and gases as well as working safety and prevention of accidents must be followed. (In Germany: working safety rules and corresponding directives.)

If the PHE is working with fluids of group 1 (EC) or with dangerous liquids or gases, special safety precautions for the class of dangerous substance may also become necessary!

Corresponding instructions to be considered by the user before installing the PHE!

Do not attempt to carry out any work on the PHE whilst it is still under pressure. All fluids must be drained and temperature of the PHE should not exceed 40°C!

When working with the plates, always wear suitable protective gloves to prevent injuries to the hands! Store and handle the plates only in horizontal position. In vertical position plates are unstable, will slip and must therefore be secured!

If injury could be caused by product leakage, the PHE must be provided with splash/drip protector!

If operating temperatures exceed 90°, heat protection or damming is required!

## 3.0 Functional description

### 3.1 Design - main components

1. fixed plate / frame plate

2. pressure plate

3. support

4. carrying beam

5. lower plate guide

6. carrier roller

7. tightening bolt

8. fixing screws

9. rubber liner

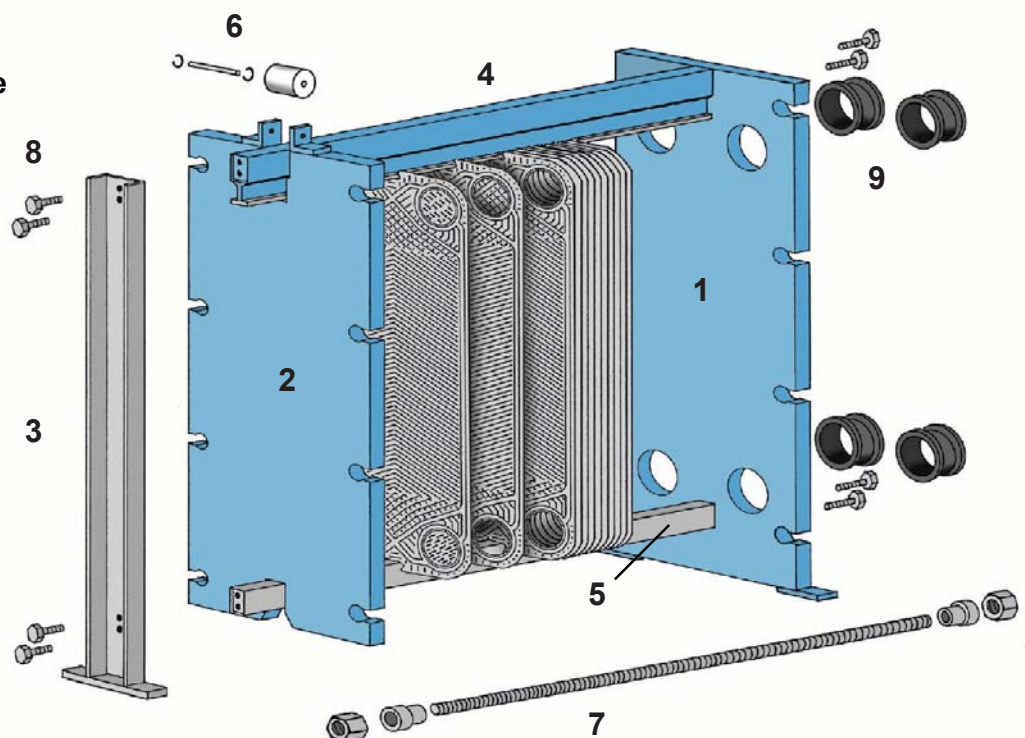


Fig. 2

**3.2 Function specification / graphical presentation**

The PHE consists of a pack with linked up embossed plates with passage openings. Every second plate is staggered by 180°, creating a flow gap at any given time. All plates are provided with clip on or glued gaskets, which completely seal the various flow gaps from the outside and separate the second media involved in heat exchange.

The plate pack is mounted in a rack and is pressed between fixed plate and pressure plate by means of clamping bolts. During service life the gaskets of a PHE are subject to a normal fatigue process and therefore the plate pack can be tightened several times - dependent on conditions of use - until "PP"-min. is reached.

Connections of media involved in heat exchange are on the fixed plate, in case of multi-pass flow also on the pressure plate (see basic scheme page 6, Fig.5).

Special materials:

Plate materials – depending on application – are chromium nickel steels, chromium nickel molybdenum steels, titanium and further materials.

Gasket materials are: NBR, EPDM, Viton, silicone and special materials



**Depending on concentration, temperature and pH-value of the medium, chlorides can affect corrosion resistance of chromium nickel steels and chromium nickel molybdenum steel (also Hastelloy, Incoloy, Inconel)!**

**3.3 Special feature of FPG, FPSF,FPSS series**

**FPG series**

Principle of design and function as described under 3.2.

The PHE of FPG series, however, consists of cassettes with 2 plates, each welded together. One outside of the cassette has a normal gasket, creating alternating flow gaps with welded external sealing and normal gasket.

This special design is used in case of higher pressures and where the medium could attack the gasket material or in refrigeration engineering.

**Attention: Cleaning of the flow gaps inside the cassettes can only be done by flushing.**

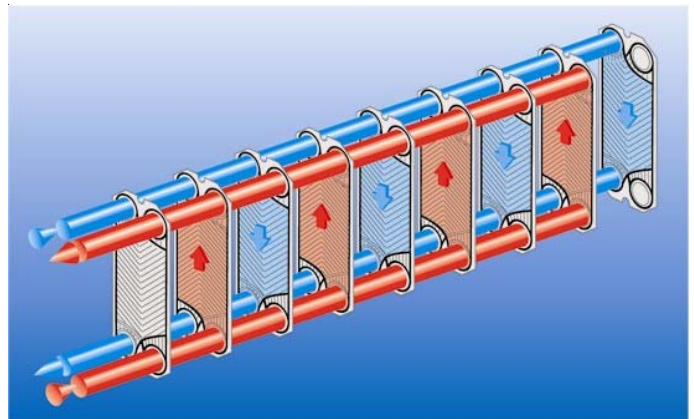


Fig.3: single-pass flow - all connections are on the fixed plate (left side)

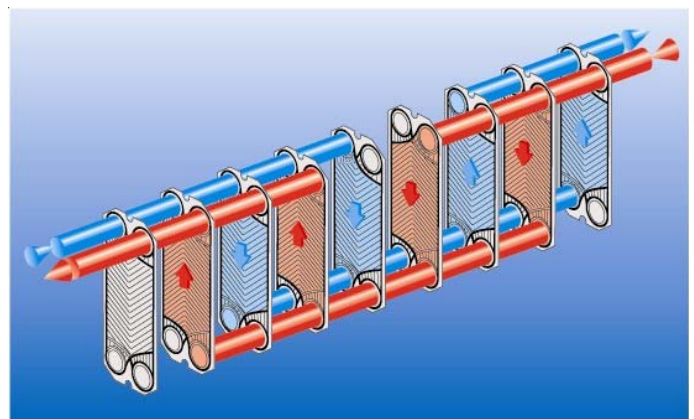


Fig. 4: multi-pass (2) flow – 2 connections are on the fixed plate and 2 on the pressure plate

**FPSF series**

This "free-flow version" has a special plate embossing, creating visibly larger free area to flow ("free flow"). Thus media with higher viscosity or even liquids with suspended solids can be used – depending upon design.

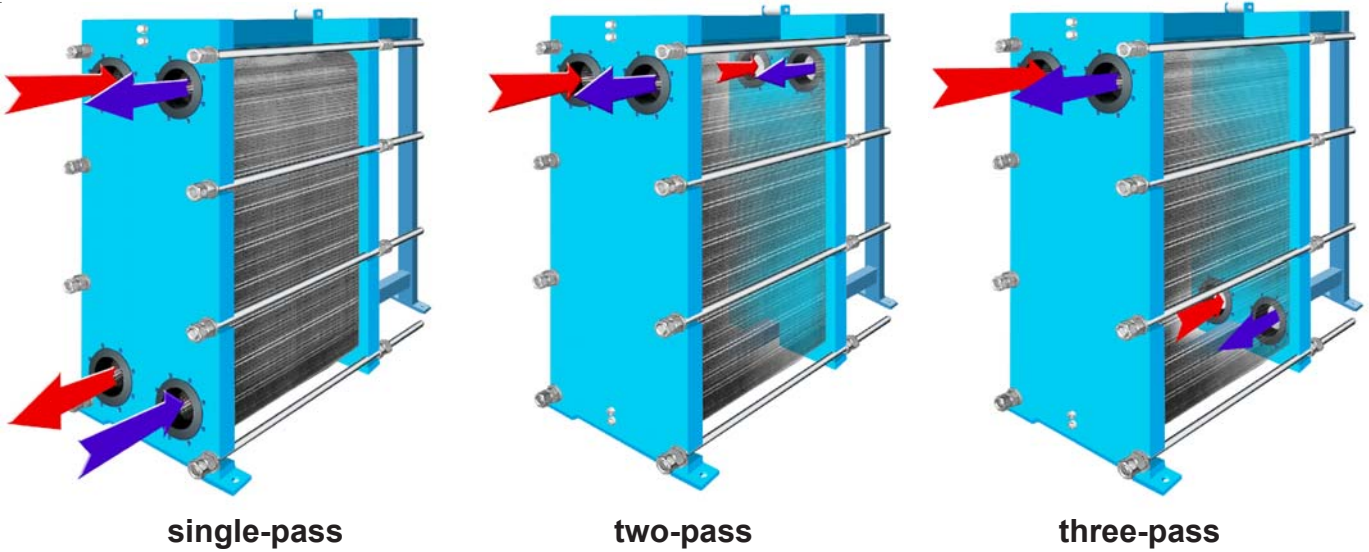
**FPSS**

The FPS safety PHE has a "double wall".

This line of products guarantees the greatest possible safety with regard to intermixing of primary- and secondary media. "One" heat exchanger plate consists of two superimposed plates. This double plate incorporates a small leakage gap. In case of a breach in the plates caused for instance by corrosive substances, the medium escapes through the leakage gap, and the double plate must then be completely replaced!

### 3.4 Position of single-pass and multi-pass connections

Fig.5



single-pass

two-pass

three-pass



**Order related allocation of connections of each PHE - exactly defined in the order specification!**

## 4.0 Transport und Installation

### 4.1 Transport handling and assembly

Usually the PHE is delivered either in horizontal or upright position to be lifted by a forklift truck from beneath the planks. (see figure 7). Larger PHE are lifted using slings suspended from suitable forklifts or cranes)

Figure 8 shows the slow setting upright over centre of gravity  
 Figures 9 and 10: Fastening of a suspension rope to the PHE in the upright position.

In its final position the PHE should be anchored to the ground or to the plant. Corresponding holes in the frame cradles or feet are provided for this purpose. Further fixing possibilities in accordance with order specification or technical documentation.



**Do not lift the PHE at connection points!**

**Do not use bright steel ropes or chains for lifting!**



Fig. 6

**Suspension ropes must be fixed carefully and if necessary secured against slipping!**

Fig. 7



Fig. 8

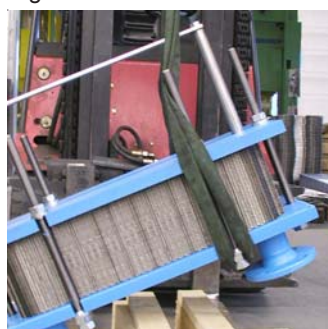


Fig. 9

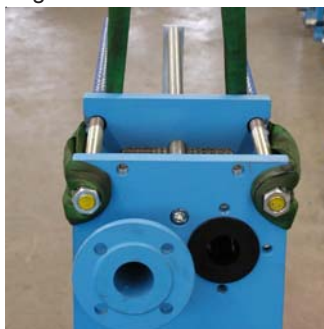
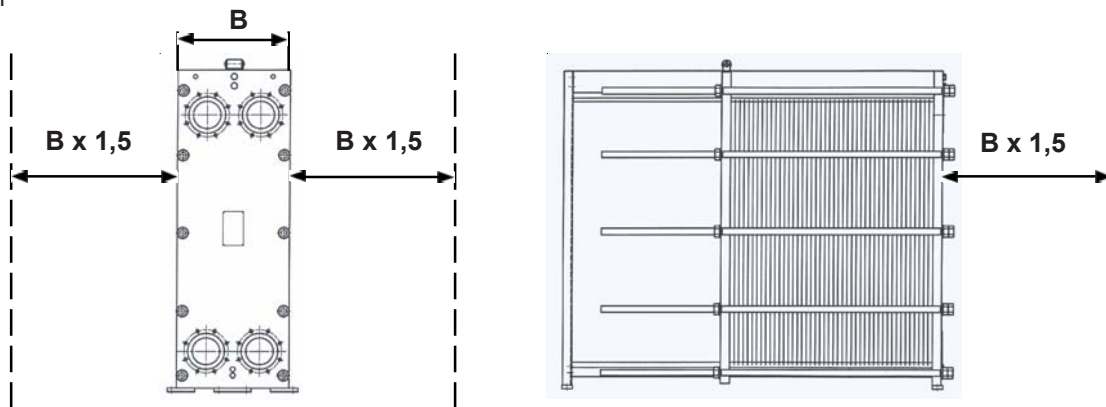


Fig. 10



## 4.2 Required space / minimum distance

Fig.11



The minimum distances according to above sketches are required for quick maintenance and service works at site (for instance replacement of plates or tightening of the plate pack). Reduction of the minimum distances only after agreed by FUNKE.

## 4.3 Ambient conditions – job site requirements and storing requirements



The PHE standard units are designed for use in closed frost-free rooms.

In case of outdoors installation or if used in rooms with high atmospheric moisture (> 70%) a special safety device or a special design is required.

The standard PHE works on flat ground in vertical position, unless order specification requires a different fitting position.

Furthermore, it must be ensured that the ambient temperature does not exceed the max. allowable operating temperature of the PHE and that gaskets of the PHE are protected against mechanical influence or harmful effects (for instance by acids, gases).

Make sure that no ozone generating appliances are used at job site or in the storage room (for instance arc-welding set). Ozone causes premature hardening of Elastomer gaskets. The same applies to direct solar radiation/ultraviolet light.

In case of outdoors storage, a corresponding cover shall protect the PHE against any climatic effects like moisture, sunlight, and freezing).

The tightening bolts should be greased to minimise rust formation.



**- Safety and fire regulations at job site must be observed particularly if fluids of category 1 (hazardous materials/ substances) are used.**

**- If the PHE is operating in areas where leakage is dangerous, a splash/drip protection is required! Where operating temperatures are exceeding 90°C, heat protection or damming is required!**

#### 4.4 Pipe assembly

For both circuits of the PHE vent valves must be installed at the highest point of the connections, enabling the air to escape when filling the unit.

The "opening space" of the PHE, which is between the pressure plate and support (see fig. 12) should not be obstructed by fixed piping.

Prior to assembly, the plate pack should be checked to ensure the pack is correctly tightened (especially in case of a multi-pass PHE). Compression dimension of a new PHE or a PHE with new gaskets is "pp max." (see nameplate or technical documentation! Item 6.4. describes the tightening of the plate pack.)

Connections on pressure plate or on connecting pieces must always be flexible and must run parallel to the tightening bolts. For this purpose expansion joints must be installed. All feeding and discharging pipes should always have shut-off valves to isolate the PHE from adjoining systems during maintenance.



**No forces or vibrations to the connections of the PHE are allowed.**

**The piping system shall be secured against sudden pressure surges and temperature fluctuations.**

**Between feed systems working on the piston principle and the PHE vibration dampers must be installed.**

**Quick-acting valves must be avoided!**

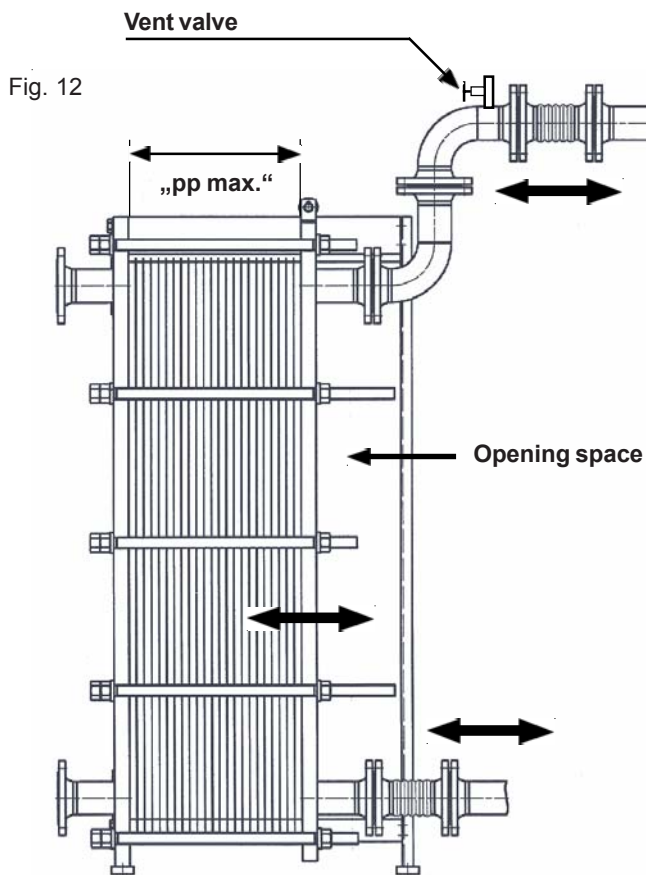


Fig. 12 Piping assembly of a PHE (multi pass) with connections on fixed plate and pressure plate (on the right of the picture)

## 5.0 Operating instruction

### 5.1 Initial operation

I. Before starting up new units make sure that the plate pack is tightened to the correct compression dimension "pp max.". If necessary tighten again as described in item 6.4.

II. Check if media, pressure and temperature data correspond to data on the name plate and specified by order!

III. Check if piping connection is correct

### 5.2 Starting up the PHE

Description for one flow direction of the PHE

1. Feed valve between pump and PHE is shut
2. Fully open the valve at outlet nozzle (if present)
3. Open the vent valve
4. Start pump
5. Slowly open the feed valve
6. Close vent valves after the air completely escaped from the PHE

Repeat steps described above for the second flow direction of the PHE.



## 5.3 Operation



Do not operate the PHE under pressure and temperature conditions exceeding the values specified on the nameplate and in the technical documentation.

To operate with severe temperature jumps and hydraulic shocks may cause mechanical damages or material damages and is generally not allowed! Otherwise the manufacturer will not be responsible and will not accept any guarantee for damages caused to the PHE!

In case of severe temperature variations and sudden hydraulic shocks shut down the PHE until defect is eliminated. In any case the PHE must be checked!

Operating data of the PHE must be regularly recorded and evaluated to detect fouling immediately. Visual control have to be done monthly (minimal interval).

The PHE must be checked for tightness by qualified personnel regularly.

## 5.4 Operational shut-down / shut down for a longer period

If the PHE is out of service for just a short period proceed as follows:

1. Slowly close the feed valves (flow direction with higher pressure first)

2. Switch off pumps

3. Close valves in outlet pipes (if present)

If the PHE is out of service for extended periods of time proceed as follows:

4. Vent the PHE and drain all fluids.

5. If necessary rinse the plate pack or clean acc. to item 6.0

6. Expand the plate pack by adding 10 % to the compression dimension (last compression dimension "pp" + 10 %)

Storage instructions of item 4.3 to be followed!

## 6.0 Maintenance / Repair

### 6.1 Basic instructions for maintenance

Read all basic safety instructions (see item 2.0) before starting maintenance and repair works!

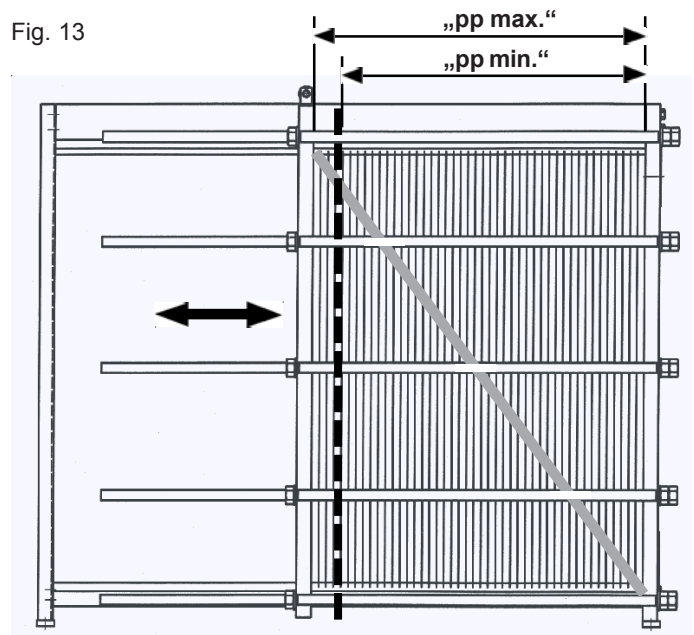
Necessary maintenance intervals of a PHE may be very different depending on the diversity of media used. Therefore, it is recommended – in addition to the regular check described in item 5.3 – to maintain the opened PHE once a year at least. During service life the PHE gaskets are subject to a normal fatigue process.

The plate pack can be tightened several times – dependent on conditions of use – until "PP" min. is reached (see 6.4)

Definition of compression dimensions (length of plate pack): (see fig.13)

- „pp max.“ = compression dimension of new PHE or PHE with new gaskets
- "pp min" = minimum compression dimension allowed
- "pp" – Current compression dimension between "pp max." and "pp min." after tightening

Fig. 13



Recommendation:

Paint a diagonal coloured line across the side of the plate pack to ensure that the plates are reassembled in the right order.

## 6.2 Shut-down and opening of the PHE

1. slowly close the feeding valves (first the side with higher pressure)
2. switch off the pumps
3. close valves of outlet pipes
4. cool down the PHE to approx. 40°C
5. vent the PHE and drain all fluid channels
6. In case of a multi-pass PHE: Disconnect all feed lines at compression plate and if necessary also at intermediate elements

Before opening the PHE proceed as follows:

1. Clean the outside of carrier roller, carrying beam and lower plate guide and plate pack.  
Grease carrier roller if necessary.
2. Clean and grease tightening bolts
3. Paint a diagonal coloured line across the side of the plate pack (see fig. 13)
4. Note the current compression dimension "pp".

### Removal of tightening bolts at compression plate and opening of the PHE (see figure 14)

1. The first tightening bolts shown on the sketch may be removed in any order.  
The four remaining tightening bolts maintain equal pressure distribution over whole the plate and should not be removed.

2. Tightening bolts 1 – 4 (acc. to sketch) to be unscrewed diagonally in pairs, alternating as follows:

1 – 2, 3 – 4, 1 – 2, 3 – 4 and so on.

Make sure that the pressure plate does not tilt more than 10 mm over the width (1-3/4-2) and more than 20 mm over the diagonal (1-2/3-4)! (see figure 15)

3. After all the tightening bolts are removed, slide the pressure plate up to the end column. The plate pack is now accessible.

If possible fasten the pressure plate to avoid slipping! (on ships for instance)

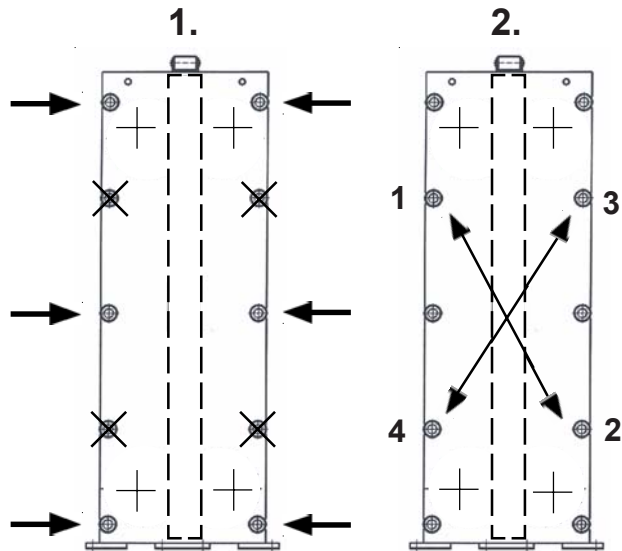
Now the single plates can be swivelled towards the pressure plates to be removed from the lower plate guide. Then laterally swivel and remove them. (see figures 16/17 )



**Never unscrew the fixing screws on frame plate!**  
**Wear protective gloves when handling the PHE plates.**  
**Plates may have sharp edges. Remove and put in only one plate at the same time – danger of accident!**

Example of how to unscrew tightening bolts on pressure plate:

Fig. 14



For maintenance and repair works all removed plates are to be handled and stored in horizontal position! Do not stack more than 60 plates!

When removing the plates make sure that the order and direction are not changed (technical documentation)!

Note: Different plates may be combined in a PHE.



Figure 15: Correct opening of the PHE and check of allowed inclination of the pressure plate.

## Removal of plates:



Fig. 16



Fig. 17

For oils, greases, biological contamination – bacteria, formation of algae and the like:

Cleaning agent: caustic soda solution  
 Concentration: max. 4 %  
 Temperature: 85 °C  
 Recommended reaction time: up to 24 hours

In any case the safety instructions of the cleaning agent manufacturer must be followed!

Always clean with chloride-free or low-chloride water with low degree of hardness.



## 6.3 Cleaning of plates

Soft deposits on plates may be removed with circulating hot fresh water and a soft brush directly when the PHE is opened (see figure 18).

To remove more stubborn deposits a high-pressure cleaner can also be used.



Care should be taken to ensure the surface (passive layer/ oxide layer) of stainless steel plates are not be damaged by cleaning. Therefore, abrasive cleaning or polishing agents and metal brushes etc. should not be used! When using a high-pressure cleaner, keep enough distance from the plate to avoid the possibility of gaskets being dislodged from the groove by the high-pressure water jet!

Very stubborn plate deposits can be removed in an open chemical bath.

The chosen chemical should be compatible with the gasket and plate materials and its suitability must be confirmed by the manufacturer of the cleaning agent.

Some suggested cleaning agents:

In case of calcareous sediment or similar incrustation:

Cleaning agent: phosphoric acid  
 Concentration: max. 5 %  
 Max. temperature: 20°C  
 Recommended reaction time: approx. 1 hour

**Chlorides reduce corrosion resistance of chrome-nickel steels and chrome-nickel molybdenum steels (also Hastelloy, Incoloy and Inconell!), depending on concentration, temperature and pH-value of the medium.**



Fig. 18

Manual cleaning of plates with contamination easily to be removed.

After cleaning always rinse with adequate clear water.

## 6.4 Replacement of plates and gaskets

Most of the PHE-gaskets are mechanically fixed in the gasket groove in a press-stud system without any glue. The gaskets are fastened locally at certain distances in the gasket groove. (figure 19/20). Gaskets can be replaced very quickly. Before fastening new gaskets the gasket groove must be cleaned carefully.

Special lines of products have glued gaskets with solvent-free glue such as

- 3 M Scotch-Grip 1099 (one-component adhesive) or
- UHU plus endfest 300 (mixed adhesive)

Replacement of glued gaskets:



**When carrying out aforementioned works always follow the accident prevention rules, the fire prevention rules and also the precautionary instructions given by the glue manufacturer!**

**Make sure that the workroom is sufficiently ventilated!**

1. For removal of old gaskets heat the reverse of the gasket groove with hot air to approx. 150°C. The glue softens sufficiently and the gasket can be removed from the groove.

Attention: Superheating of the plates must be avoided (temper colours)

Remove glue residues in the groove with a blunt object (plastic or wood – but not metal) to ensure there is no scratching of the gasket groove or plate surface.

2. Glue new gaskets as follows:

- Clean the groove of the PHE plate and the gaskets with extreme care to remove grease and then rub dry with a lint free cloth or absorbent paper!
- In case of mixed adhesive: Mix the adhesive binder and hardener according to manufacturer's instructions. Never use the same spatula or spoon. Pay attention to the curing time!
- Fill a manual injection gun with the adhesive mixture (in case of one component adhesive a bottle with spout) and apply a strand of adhesive (thickness approx. 1 mm) to the plate groove (figure 21)
- Distribute the strand uniformly throughout the base of the groove with a short-cut brush.
- Insert the gaskets into the groove and press them into place by hand.



Fig. 19



Fig. 20

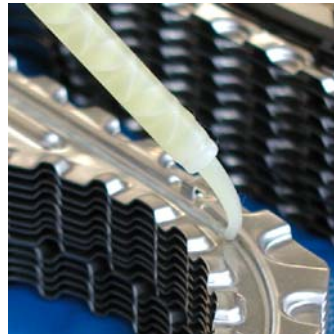


Fig. 21



Fig. 22 (FP 04, 08, 14, 20)

Attention: Some plate sizes have additional punched holes beside the gasket groove into which the gaskets must also be pressed using a short screwdriver. (figure 22)

After all gaskets are inserted, stack the plates on a flat surface. Each stack should not exceed 60 plates! Cover the stack of horizontal plates with a gasket-free plate and place a flat steel plate or something similar on top to apply pressure.

The adhesive needs approx. 12 hours at room temperature to cure. (Observe manufacturer's data). Higher temperatures will accelerate curing as follows:

at 40°C to 180 minutes

at 70°C to 45 minutes and

at 110°C to 10 minutes (does not apply to one-component adhesive).

After curing, remove excessive adhesive which may have squeezed out of the groove with a blunt object (wood or plastic).

Attention:

After all working steps the plates must be stacked in the correct order. Otherwise follow the flow diagram of the technical documentation.

## 6.5 Closing and tightening of the PHE

Before closing the PHE:

1. Check if all gaskets and plates are clean (also smallest foreign matters on the gaskets may cause a leakage).
2. Make sure that the ring gaskets or rubber inserts in the connections are clean.
3. Clean the upper carrying beam and apply a thin grease layer.

4. Install all cleaned plates in the correct order and quantity in accordance with the flow diagram (in the reverse order as described in item 6.1 )

Pay attention to the special first plates and end plates (figure 23) at fixed plate and pressure plate or intermediate elements (in case of PHE with several sections)!

The gasket of the first plate points towards the fixed plate (figure 24).

By means of the diagonal coloured line painted on the outside of the plate pack before opening the PHE you can additionally check if the plates are in the right order. When all plates are correctly installed the outside of the plate pack shows a continuous honeycomb pattern (figure 25).

Plates of a smaller PHE can also be installed in horizontal position. (figure 26).

5. Push the pressure plate against the plate pack, slowly and evenly.

6. First attach the greased tightening bolts 1-2-3-4 from the side or insert them in an axial direction (figure 27). Make sure that the counter nuts at the fixed plate are tight.

7. Fasten the tightening bolts 1-4 uniformly and in rotation (alternating and diagonal 1-2 and 3-4). During tightening continuously check the compression dimension "pp". (see also picture 15 on page 10).

During tightening, the tilt of the pressure plate shall not exceed 10 mm over the width (1-3/4-2) and 20 mm over the diagonal (1-2/3-4)!

The current final compression dimension "pp" shall not vary by more than max. 2 mm among the individual tightening bolts!

8. After tightening the plate pack with bolts 1-4 (see 7 above) to compression dimension "pp" (before opening the PHE), the remaining tightening bolts can also be fixed and tightened to compression dimension "pp".

**If all gaskets and plates have been completely replaced, tighten to "pp max."**. (Figure 28)

*Continue page 14!*



Fig. 23

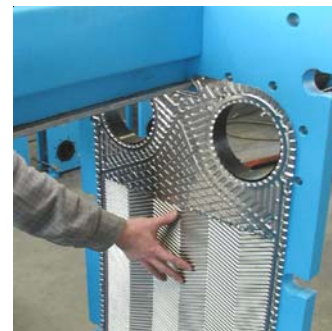


Fig. 24

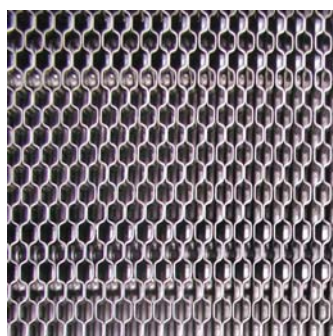


Fig. 25



Fig. 26

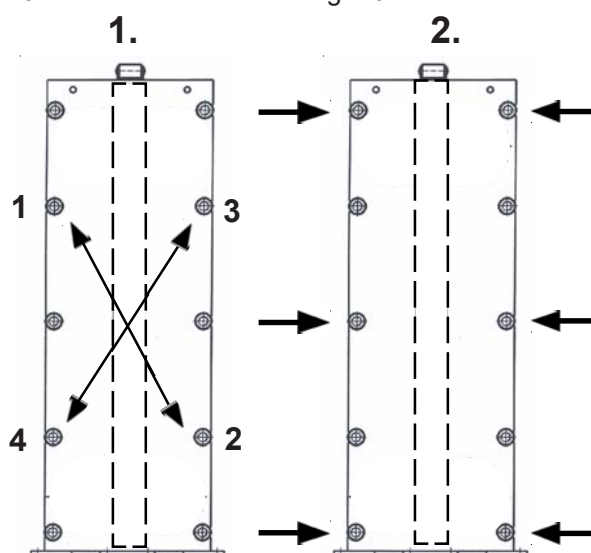


Fig. 27

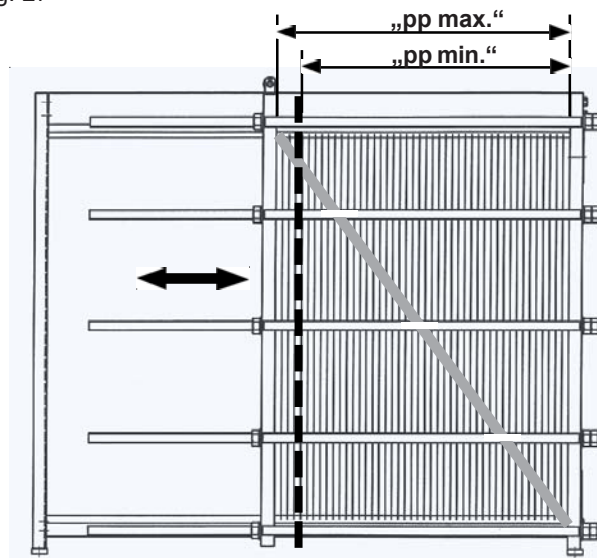


Fig. 28

If the current "pp"-dimension is not achieved or is exceeded, check if the number of plates in the plate pack corresponds to the number of plates shown in the flow diagram. Furthermore, check if tightening nuts can be turned freely.

If the plate pack is leaking during the pressure test, the pack can be tightened step by step until compression dimension "pp min". is reached.



Never tighten to below dimension "pp min". Otherwise plate profiles could be damaged and the unit will not seal or operate correctly. "pp min" and "pp max" values are shown on the nameplate and in the technical documentation.



Tighten only after the pressure has been released from the PHE!

Definitions of compression dimensions (length of plate pack):

- "pp max" = compression dimension for new PHE and PHE with new gaskets
- "pp min" = min. allowed compression dimension
- "pp" = current compression dimension after tightening between "pp max" and "pp min".

## 6.6 General maintenance works

Operating data of the PHE must be regularly recorded and evaluated to detect fouling immediately. Visual control have to be done monthly (minimal interval). Qualified personnel must check tightness and compressive strength of the PHE regularly.

All flexible parts must be greased efficiently to open the PHE easily at any time.

Particularly the following parts are concerned:

- surfaces between tightening nuts and pressure discs or pressure pieces
- thread of tightening bolt
- bearing of carrying roller at pressure plate and intermediate elements (if existent)
- carrying beam and lower plate guide, above and below.

Maintenance of steel frames:

The steel frames, coated with a weather-protective cold-cured synthetic resin, can be cleaned with a sponge, a cloth or a soft brush and a sub alkaline solution. Damaged paintwork should be "touched up" after cleaning-

Maintenance of stainless steel frames:

Stainless steel frames (or covered with chrome-nickel steel) should be cleaned in the same way as steel frames and subsequently - in a dry condition - should be rubbed with acid-free grease.

To open the PHE for maintenance and repair works is only necessary where increased pressure drops, temperature variations or leakages cannot be eliminated in a different way. (Opening PHE: see chapter 6.0)



Preventive maintenance is recommended once a year, depending on conditions of use.

## 7.0 Troubleshooting



National and international directives for pressure equipment (PED), dangerous liquids and gases as well as for prevention of accidents must always be followed!

It is not allowed to carry out maintenance works and repair works when the PHE is under pressure!

If the PHE must be opened for removal inspection: After closing the plate pack it must be tightened again to the compression dimension "pp", (current compression dimension "pp" before opening) or can be gradually reduced to "pp min" until the required compressive strength is reached. Proceed as described in item 6.0

## Leakage between connection and fixed plate

Possible causes:

- stress and force is acting on the connection
- faulty ring gaskets, rubber liner or flange bolting
- age induced material fatigue or material wear


Proceed as follows:

1. Check flanged joint and uniformly tighten loosened screws.
2. Check piping system for stress and force acting on the joint

Check alignment and squareness of flanges and piping and correct if necessary.

If the leakage cannot be cured, the joint must be faulty.

Proceed as follows:


1. Open the PHE as described in item 6.0 
2. Release connection. Check, clean and if necessary replace the gasket

## Leakage between plate pack and fixed plate or pressure plate

Possible causes:

- faulty ring gaskets or rubber liner on the inside of the fixed plate or pressure plate
- faulty gasket or wrong fitting of the first plate
- age induced material fatigue or material wear

Proceed as follows:

1. Mark leaking point 
2. Open the PHE as described in item 6.0
3. Check if the first plate gasket is correctly fitted to the frame plate and correct if necessary.

Clean or replace the gasket if necessary.

4. Check if rubber parts or gaskets at fixed plate or pressure plate are defect and replace if necessary.

## External leakage between plates

Possible causes:


- allow. operating pressure or temperature has been exceeded
- pressure plate is not tightened plane-parallel
- incorrect compression dimension "pp"
- incorrectly positioned or damaged gaskets
- age induced material fatigue or material wear

Proceed as follows:

1. Adjust operating pressure or temperature to the allow. value and , if necessary:
2. tighten pressure plate square and parallel and, if necessary:
3. adjust compression dimension "pp" correctly or reduce to "pp min" step by step.

The compression dimension "pp" between the tightening bolts shall not differ by more than 2 mm!

If necessary:


4. open the PHE as described in item 6.0. 
- Check correct fitting of the gaskets and if necessary clean and replace damaged gaskets.

## Internal leakage / mixing of media

Possible causes:

- two defects at the double gasket near inlet area of a plate (rarely)
- pitting corrosion or micro crack
- blockage of external leakage opening of the plate gasket near inlet

Proceed as follows:

1. open the PHE as described under 6.0 
  2. drain one of the flow channels
  3. remove the connecting pipes of this flow channel
  4. apply slight pressure to the other flow channel
- Through the leakage the water enters the open flow channel and then escapes through the pipe connection. The defective plate gap can be located by means of a spotlight or big pocket torch.
5. check the gasket and the total surface of the defective plate, clean it and if necessary replace the complete plate.


In case of a small internal leakage, which cannot be localised in the way described above, the plates must be cleaned separately and must then be checked using a big lamp.

Replace defective gaskets or complete plate.

In the event crack detection testing is required, please contact FUNKE.

## Heavily decreasing performance of the PHE

If pressure drops are clearly increasing or performance is heavily decreasing, first check if this is caused by problems elsewhere in the production system (for instance changing quality of the media, changing inlet temperature or changing volume flow)

If no improvement is shown the PHE must be shut down and cleaned as described in item 6.0. 

First check if foreign substances or deposits hinder the flow.

## Compression dimension "pp" reached

Age induced material fatigue or material wear – insufficient reset power of the gaskets, wear limit is reached.

A complete replacement of all gaskets is required.



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