

## INSTALLATION AND MAINTENANCE INSTRUCTIONS ADCATHERM PAT - Plate Heat Exchangers

### 1 - GENERAL

1.1. These instructions refer to standard design of Valsteam ADCATHERM PAT - Plate Heat Exchangers. Special designs may require supplementary operating and maintenance instructions. Please always follow the specifications related to the respective model.

1.2. Before starting the maintenance services, staff must be instructed by the user. The operation manual should be always available and it must be understood. If any instructions are not understood please contact the factory before carrying on any maintenance operation.

1.3. ADCATHERM PAT are designed for special conditions of use specified by the customer, concerning temperature, pressure, volumetric flow and media and are fabricated in conformity with PED 97/23/EC.

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

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

**NOTE: Every time the below Attention symbol is shown, all the instructions have to be followed carefully!**



**ATTENTION**

#### **Warning!**

- ADCATHERM PAT is pressure-containing equipment and shall be connected, operated and maintained only by qualified personnel!
- National and international directives for pressure equipments (Europe: PED 97/23/EC), dangerous liquids or gases, special safety rules must be followed. If the PAT is working with fluids of group 1 (PED 97/23/EC) or with dangerous liquids and gases, special safety precautions for the class of dangerous substance may also become necessary!
- Consider all the necessary instructions mentioned in this instructions manual before install the PAT.
- Do not attempt to carry out any work on the PAT while it is still under pressure. All the fluids must be drained and temperature of the PAT should not exceed 40°C!
- Before installing or starting maintenance be sure to have sufficient space to work in and also the correct lifting gear and qualified staff.
- 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 PAT must be provided with splash/drip protector (available under request)!
- If operating temperature exceeds 90°C, heat protection is required (available under request)!
- If any of the socket connections is not being used, it must be closed with an appropriate material plug.
- Do not remove the nameplate attached to the equipment. Serial number and other useful information stamped on it.
- Do not lift the PAT at connections points! Do not use bright steel ropes or chains for lifting!
- Suspension ropes must be fixed carefully and if necessary secured against slipping.

### 2 - DESIGN – MAIN COMPONENTS

Main components of ADCATHERM PAT according with picture n°1.

- 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.

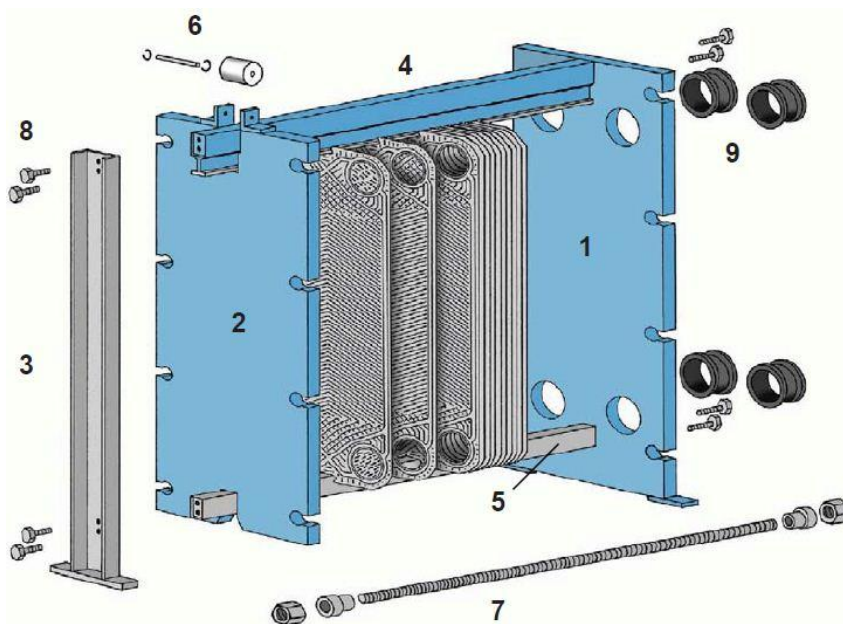


Fig. 1

### 3 - FUNCTION SPECIFICATION

The PAT consists of a pack with linked up embossed plates with passage openings. Every second plate is staggered by 180°, creating flow gaps 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 time the gaskets of PAT 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; however other designs can also have connections on the pressure plate.

### 4 - TRANSPORT AND INSTALLATION

#### 4.1. Transport and PAT anchoring

Usually the PAT is delivered either on horizontal or upright positions to be lifted by a forklift truck from beneath the planks (see figure 2). Larger PAT are lifted using slings suspended from suitable forklifts or cranes. Figure 3 shows the slow setting upright over centre of gravity. Figures 4 and 5, show how to fasten one suspension rope to the PAT in the upright position.



Fig. 2



Fig. 3



Fig. 4

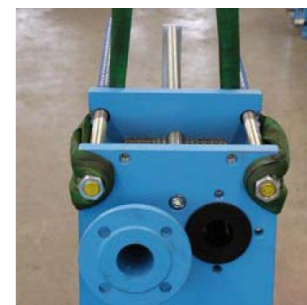


Fig. 5

In its final position the PAT 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 provided in accordance with order specification or technical documentation.

#### 4.2. Required space/minimum distances

The minimum distances according to fig. 6 are required for quick maintenance and operation at site (for instance: replacements of plates or tightening of the plate pack).

The standard PAT works on a flat surface in vertical positions, unless in the order specification a different fitting position was required.

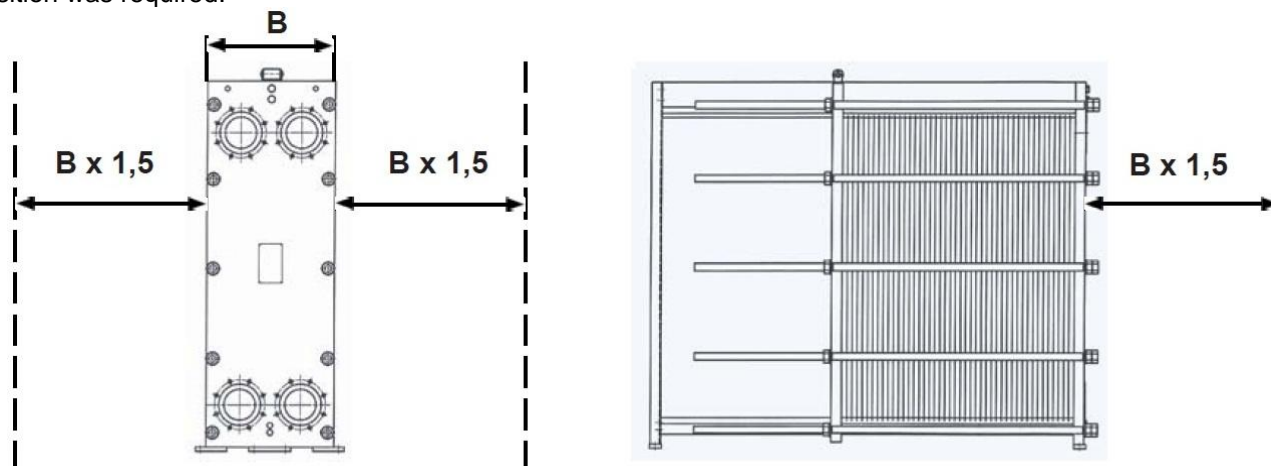


Fig. 6

#### 4.3. Ambient conditions

The PAT standard units are designed for use in closed frost-free rooms. In case of outdoor installation or if used in rooms with high atmospheric moisture (>70%) a special design or safety device is required.

Furthermore, it must be ensured that the room temperature does not exceed the maximum allowable operating temperature of the PAT, and the gaskets are protected against harmful effects (acids, gases...).

Make sure that no ozone generating appliances are used at the 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 PAT against any climatic effect like moisture, sunlight and freezing.

The tightening bolts should be greased to minimize rust formation.

#### 4.4. Pipe assembly

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

The "opening space", which is between the support and pressure plate, should not be obstructed with fixed piping to allow easy maintenance operations.

Before installation remove plastic covers placed on flanges or connection ends. The equipment has an arrow or Inlet/ Outlet designations. Be sure that it will be installed on the appropriate flow direction.

Prior to assembly, the plate pack should be checked to ensure the pack is correctly tightened. Compression dimension of a new PAT or PAT with new gaskets is "pp max" (see nameplate on the equipment).

Connections on pressure plate or on connection 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 isolating valves to isolate the PAT from the systems during maintenance.



#### ATTENTION

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

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

**Systems with high vibration possibility, vibration dampers must be installed.**

**Quick acting valves must be avoided!**

## 5 – OPERATION INSTRUCTIONS

### 5.1. Initial operation:

I - Before starting up new units make sure that the plate pack is tightened to the correct compression dimensions: “pp max”. If necessary tighten again as described in section 6.5.

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. Start-up the PAT

To start up the PAT these following steps must be followed, each time for each flow.

1 – Feed valve between pump and PAT is shut;

2 – Fully open the valve at outlet nozzle (if manual valve is fitted);

3 – Open the vent valve (if this is manual);

4 – Start pump;

5 – Slowly open the feed valve;

6 – Close vent valves after the air completely escaped from the PAT (if this valve is manual operated).

Repeat these steps for the second flow direction.



#### ATTENTION

***Do not operate the PAT under pressure and temperature conditions exceeding the values specified on the nameplate and in the technical documentation!***

***Operating with severe temperature jumps and hydraulic shocks may cause mechanical damages or material damages and is generally not allowed! Otherwise VALSTEAM ADCA Eng. S.A. will not be responsible and will not accept any guarantee for damages caused to the PAT.***

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

***Operating data of the PAT must be regularly recorded and evaluated to detect fouling immediately. Visual control has to be done monthly (minimal time gap).***

***The PAT must be regularly checked for tightness by qualified personnel.***

### 5.3. Operation and shut-down

If the PAT 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 PAT will be out of service for extended periods of time proceed as follows:

4 – Vent the PAT and drain all fluids;

5 – If necessary rinse the plate pack or clean acc.with section 6.

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 – MAINTENANCE / REPAIR

### 6.1. Basic instructions for maintenance



#### ATTENTION

***Read all the basic safety instructions (see Warnings - first page) before starting maintenance and repair service!***

Necessary maintenance periods of this product may be very different depending on the diversity of media used. Therefore, it is recommended – in addition to the regular operations described in **section 5** – to maintain the opened PAT at least once a year. During life service, the PAT gaskets are subject to a normal fatigue process.

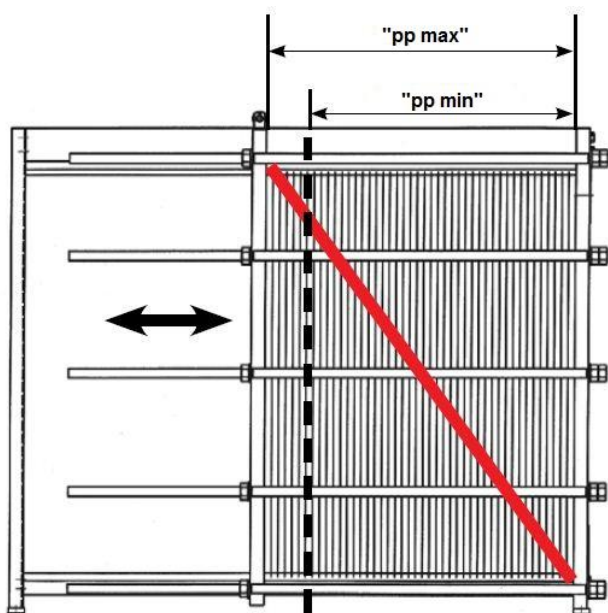
The plate pack can be tightened several times – depending on conditions of use – until “pp min” is reached (see **section 6.4.**).

Definition of compression dimensions (length of plate pack) - (see fig. 7):

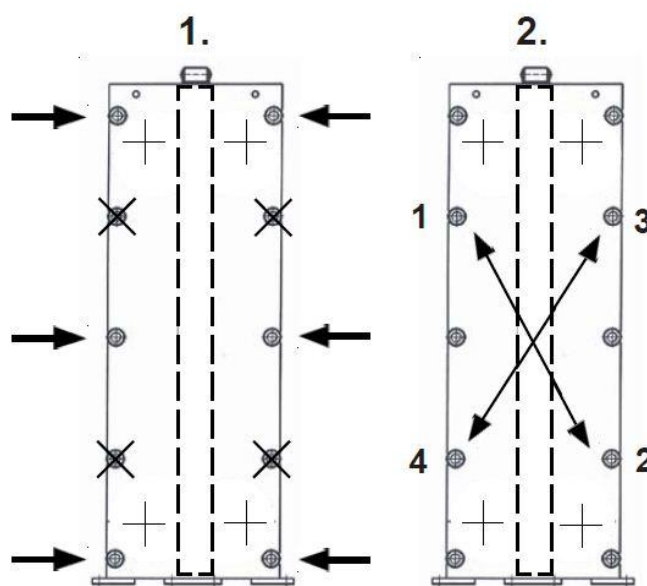
- “pp max” = compression dimension of new PAT or PAT with new gaskets;
- “pp min” = minimum compression dimension allowed;
- “pp” – Current compression dimension, between “pp max” and “pp min”, after tightening.

**Recommendation:**

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



**Fig. 7**



**Fig. 8**

**6.2. Shut-down and opening of the PAT**

1. Slowly close the feeding valves (begin with the side with higher pressure);
2. Switch off the pumps;
3. Close valves of outlet pipes;
4. Cool down the PAT to approx.40°C;
5. Vent the PAT and drain all fluid channels.

Before opening the PAT proceed as follows:

1. Clean the outside of carrier roller, carrying bar, lower guide bar and plate pack. Grease carrier roller if necessary;
2. Clean and grease tightening bolts;
3. Paint a diagonal colored line across the side of the plate pack (see figure 7).
4. Note the current compression dimension “pp”.

**Removal of tightening bolts at pressure plate and opening of the PAT (See figure 8).**

1. The first tightening bolts shown on the Figure 8, Number 1 (indicated with arrows), may be removed in any order. The four remaining tightening bolts maintain equal pressure distribution over the plate and should not be removed.
2. Tightening bolts 1 – 4 (according to Figure 8, Number 2) are 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)!

3. After all the tightening bolts are removed, slide the pressure plate up to the support column. The plate pack is now accessible. If possible, fasten the pressure plate to avoid slipping!

It is now possible to move the lower section of the channel plate towards the pressure plate for removal from the lower guide bar. Then laterally swivel and remove them (see figures 9 and 10).

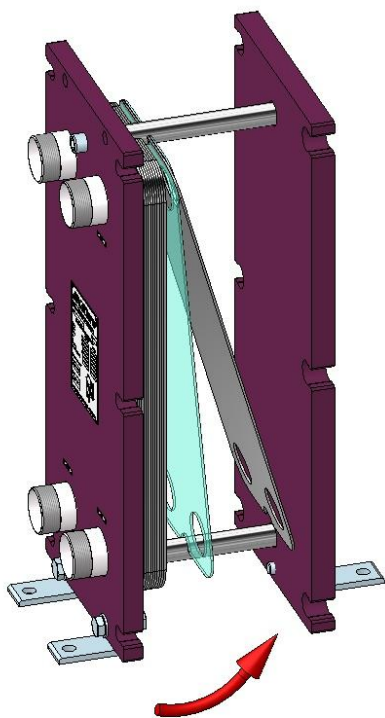


Fig. 9

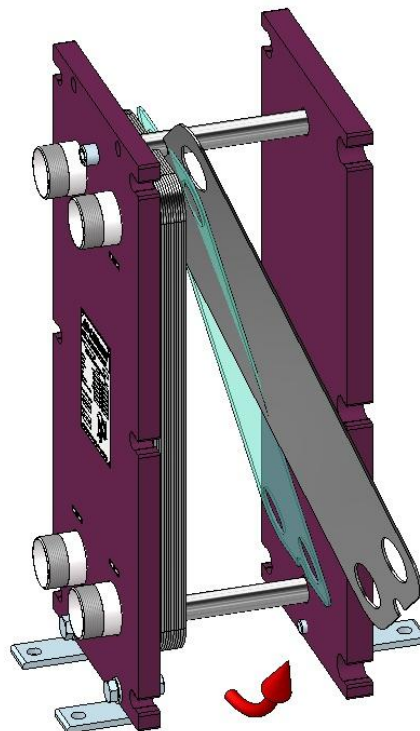


Fig. 10



**ATTENTION**

**Never unscrew the fixing screws on the frame plate (fixed plate)! Wear protective gloves when handling the PAT plates.**

**Plates may have sharp edges. Removing or adding a plate should be done one plate at a time. The disregard of these recommendations can lead to injury!**

**For maintenance and repair work 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!**

**Note: Different chevron (patterns) plates may be combined in a PAT.**

### 6.3. Cleaning of plates

Soft deposits on plates may be removed with directly circulating hot fresh water and a soft brush when the PAT is opened. To remove more hard deposits a high-pressure cleaner can also be used.

**Important notes:**

Care should be taken to ensure the surface (passive layer/oxide layer) of stainless steel plates are not damaged by cleaning. Therefore, abrasive cleaning or polishing agents and metal brushes 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 hard to remove plate deposits can be removed in an open chemical bath or by cleaning in place.

The chosen cleaning agent 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

For oils, greases, biological contamination bacteria, formation of algae and similar:

Cleaning agent: caustic soda solution

Concentration: max. 4 %

Temperature: 85°C

Recommended reaction time: up to 24 hours

The safety instructions of the cleaning agent manufacturer must be followed!

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



### **ATTENTION**

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

**Soft deposit contamination is easily removable by manually cleaning the plates.**

**After cleaning always rinse with adequate clean water.**

### **6.4. Replacement of plates and gaskets**

Most of the PAT-gaskets are mechanically fixed in the gasket groove by means of clip on or press-stud system without any glue. The gaskets are fastened locally at certain distances in the gasket groove (figure 11, 12 and 14). Gaskets can be replaced very quickly.

Before fastening new gaskets the gasket groove must be carefully cleaned.

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

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

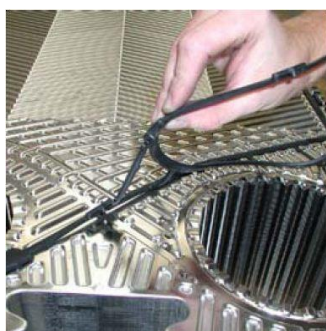


Fig. 11



Fig. 12

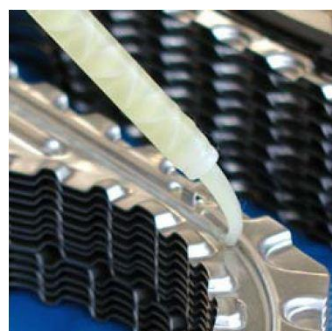


Fig. 13

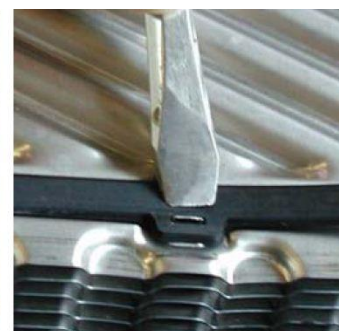


Fig. 14

### Replacement of glued gaskets:



#### ATTENTION

**When carrying out the following work always follow the accident and 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 **glued on** gaskets heat the underside of the gasket groove with hot air to approximately 150°C.

The glue softens sufficiently and the gasket can be removed from the groove.



#### ATTENTION

**Superheating of the plates must be avoided (temper colors) Remove the 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 PAT 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 of approximately 1 mm) to the plate groove (Figure 13).
- 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.



#### 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 14).**

**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 a similar weighted device on top to apply pressure.**

- 3- The adhesive needs approximately 12 hours at room temperature to cure (observe manufacturer's data).

Higher temperatures will accelerate curing as follows:

- at 40°C cures in approximately 180 minutes;
- at 70°C cures in approximately 45 minutes;
- at 110°C cures in approximately 10 minutes (does not apply to one-component adhesive).

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



#### ATTENTION

**After following all above steps, plates must be stacked in the correct order.**



## 6.5. Closing and tightening of the PAT

### Steps to close the PAT:

- 1- Check if all gaskets and plates are clean (even the smallest residue 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 section 6.1).

Pay attention to the special first plate and end plate (figure 15 and 16), at frame plate and pressure plate, or intermediate elements (in case of PAT with several sections)!

The gasket of the first plate points towards the frame plate (figure 16).

With the diagonal colored line painted on the outside of the plate pack (painted as indicated in section 6.1, figure 7) you can additionally check to ensure the plates are in the right order.

When all plates are correctly installed, the outside of the plate pack shows a continuous honey comb pattern (see figure 17).

Plates of a small PAT can also be installed in horizontal position (figure 18).



Fig. 15



Fig. 16

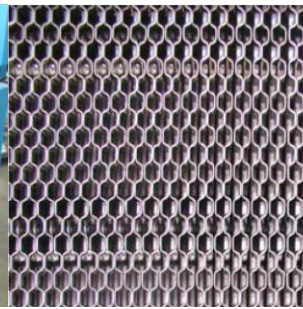


Fig. 17



Fig. 18

- 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 19). Make sure that the counter nuts at the frame plate are tight.

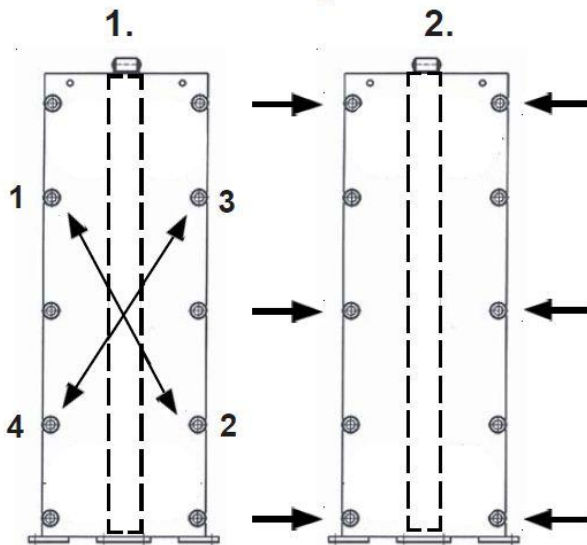


Fig. 19

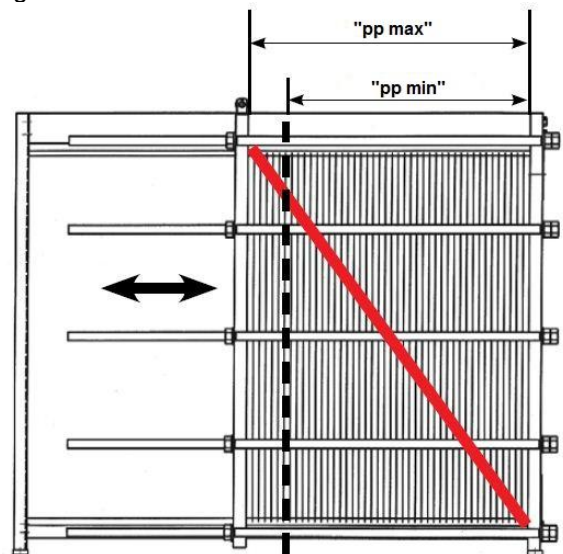


Fig. 20

- 7- Fasten the tightening bolts 1-4 uniformly and in rotation (alternating between diagonal 1-2 and 3-4). During tightening continuously check the compression dimension “pp”, the tilt of the pressure plate must 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” must not vary by more than max. 2 mm among the individual tightening bolts.
- 8- Tighten the plate pack with bolts 1-4 (see figure 19) to compression dimension “pp” (dimension noted before opening the PAT). The remaining tightening bolts must also be fixed and tightened during the process to reduce any chance of deflection of the pressure plate.  
***If all gaskets and plates have been completely replaced tighten to “pp max” (figure 20).***  
If the current “pp” dimension is not achieved or is exceeded, check if the number of plates in the plate pack is according to the PAT model (correct number of plates). Furthermore, check if tightening nuts can be turned freely.
- 9- If the plate pack is leaking during the pressure test, ensure that you don’t have a gasket out of place causing the leak. If you see no sign of misplaced gaskets at the sight of the leak then the pack can be tightened step by step until the leak has stop or compression dimension` “pp min” is reached.

**ATTENTION**

***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 PAT!***

***Definition of compression dimensions – please see section 6.1.***

## 6.6. General maintenance operations

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

Qualified personnel must check tightness and compressive strength of the PAT regularly.

All flexible parts must be greased efficiently to open the PAT easily at any time. Particularly the following parts are of concern:

- 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).
- Upper carrying bar and lower guide bar, 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 retouched 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.

Opening the PAT for maintenance and repair services is only necessary when increased pressure drops, temperature variations or leakages cannot be eliminated in a different way (Opening PAT: see section 6.0).

**ATTENTION**

***Preventive maintenance is recommended, at a minimum, once a year!***

## 7 - TROUBLESHOOTING



### ATTENTION

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

**Never perform maintenance and repair services when the PAT is under pressure!**

**If the PAT 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 it can be gradually reduced to “pp min” until the required compressive strength is reached. Proceed as described in section 6.0.**

### 7.1. Leakage between connection and fixed plate

*Possible causes:*

- Stress and force is acting on the connection;
- Worn out 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 solved the joint must be faulty.**

*Proceed as follows:*

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

### 7.2. Leakage between plate pack and frame 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 PAT as described in section 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, gaskets at fixed plate or pressure plate are in need of replacement and replace if necessary.

### 7.3. External leakage between plates

*Possible causes:*

- Operating pressure or temperature has been exceeded;
- Pressure plate is not tightened plane-parallel;
- Incorrect “pp” compression dimension;
- Incorrectly positioned or damaged gaskets;
- Age induced material fatigue or material wear.

*Proceed as follows:*

1. Adjust operating pressure or temperature to the allowed values, 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 2mm!

*If necessary:*

4. Open the PAT as described in section 6.0.

Check correct fitting of the gaskets and, if necessary clean and replace damaged gaskets.

#### **7.4. Internal leakage / mixing of media**

*Possible causes:*

- Two defects at the double gasket near inlet area of a plate (rare event);
- Pitting corrosion or micro crack;
- Blockage of external leakage opening of the plate gasket near inlet.

*Proceed as follows:*

1. Open the PAT as described in section 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 flashlight.

5. Check the gasket and the total surface of the defective plate, and clean it, if necessary replace the complete plate.

In case of a small internal leakage, which cannot be localized in the manner described above, the plates must be cleaned separately and must then be checked visually with good lighting conditions.

Replace defective/faulty gaskets or the complete plate. In the event crack detection testing is required, please contact VALSTEAM ADCA Eng. S.A.

#### **7.5. Heavily decreasing performance of the PAT**

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 PAT must be shut down and cleaned as described in section 6.0.

#### **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.

**PRODUCTS RETURNING****ATTENTION**

- Information regarding any hazards and safety measures to be considered due to contaminating fluids, residues or mechanical damage that may represent a health, safety, or environmental risk, must be provided in writing by the distributors and costumers when returning products to Valsteam ADCA engineering.
- Health and safety data sheets regarding substances identified as hazardous or potentially hazardous must be provided with the information mention above.

**ATTENTION**

- **LOSS OF WARRANTY:** Total or partial disregard of above instructions involves loss of any right to warranty.