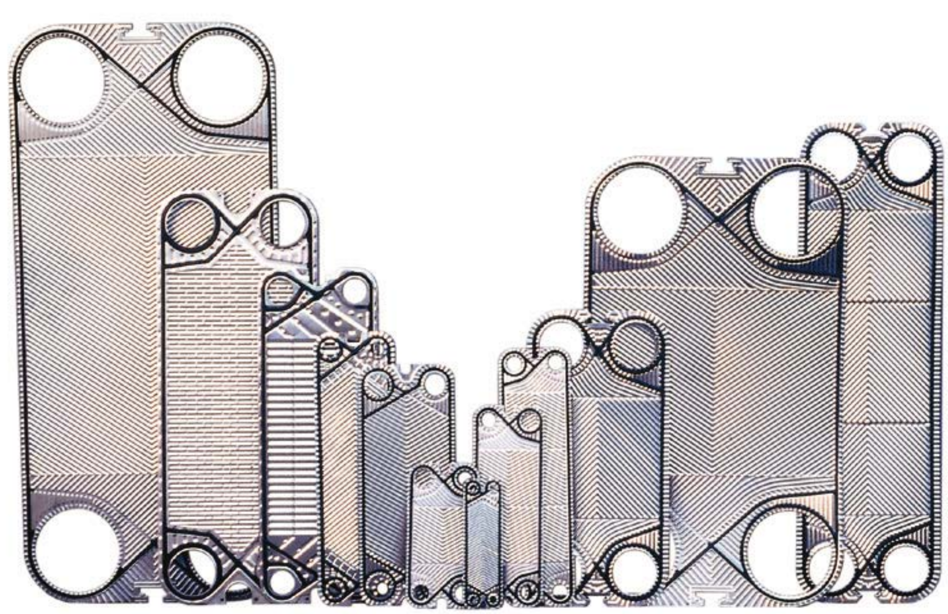
Process & Packaging, Inc.

Plate Heat Exchangers

SERVICE MANUAL



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A. Plate Heat Exchanger Description

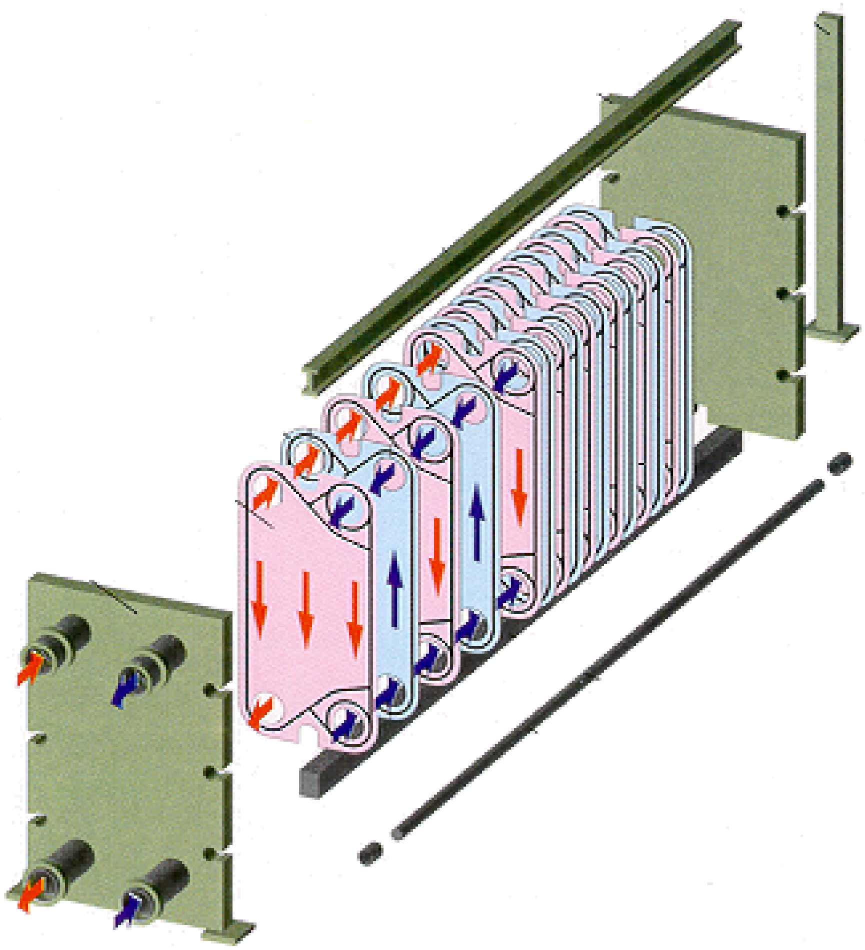
The Plate Heat Exchanger consists of a FRAME and a PLATE PACK. The frame consists of the following:

- Fixed Head
- Moveable Follower
- Carrying Bar
- Guiding Bar
- Support Column
- Tightening Bolts

The plate pack is where the heat transfer takes place. It is constructed of a series of embossed, gasketed metal plates. The plates are gasketed so that the hot and cold media flow in a parallel fashion across alternating channels.

The pack is custom-designed to the exact requirements of the heat transfer application.

TYPICAL FLUID FLOW



B. Construction and Function

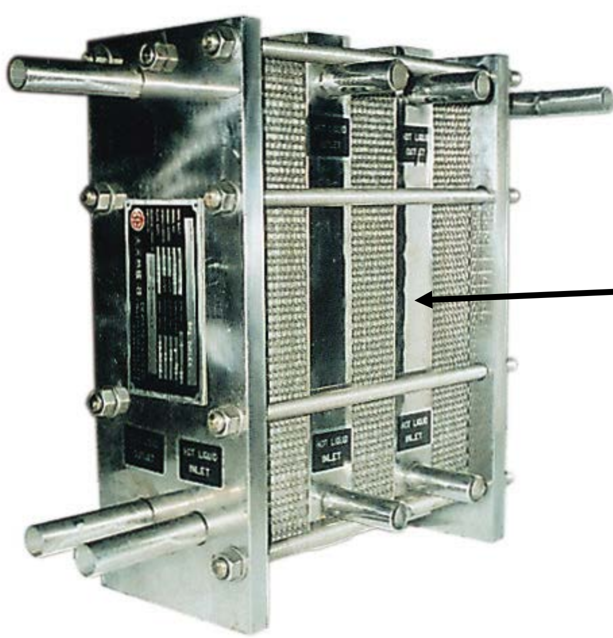
The compact design of the PHE (Plate Heat Exchanger) requires only a function of the space of a shell-and-tube heat exchanger. Both reduced heat transfer surface and lower hold-up volume means less operating weight. Plates are Manufactured in standard sizes in virtually any material that can be cold worked, such as stainless steel (304 and 316), titanium, C276, and SMO-254. The gaskets serve to seal the fluids in the plate-pack and also to direct the hot and cold media into the proper flow channels. The space between the port gasket and the perimeter gasket is vented to atmosphere. This ensures that the fluids will never intermix, and that any leaks will be to the outside of the heat exchanger.

The fluids enter the PHE through connection on the frame. A **single pass** arrangement has all four connections on the fixed head. This design is preferred, where possible, because the unit may be opened for maintenance or expansion without breaking the pipe connections. For “close-approach” applications, a multi-pass unit may be required. This arrangement puts connections on both the fixed head and the moveable follower.

The most common flow pattern is called **countercurrent**, where the fluid inlets are opposite ends of the fixed head. The co-current flow pattern is rarely used, but may be a good solution in some special cases.

SEPARATOR (CONNECTION PLATE)

Should more than one heat transfer duty be required in the same unit, a separator or connection plate can be incorporated. The separator allows two or more individual heat exchanger duties to be performed and is especially suited to UHT pasteurisation duties.



SEPARATOR OR CONNECTION PLATES

THREE STAGE PLATE HEAT EXCHANGER

C. Plate Characteristics.

The plate is designed to obtain the maximum possible heat transfer efficiency. Each plate is embossed (pressed) with a "V or W shaped" herringbone pattern. <u>The "V's or W" always point in the opposite directions on adjacent plates.</u> This create a large number of contacts points between the plates which in turn enables the plate pack to withstand high pressures with relatively thin (0-5-0.8 mm) plate materials.

In order to more closely match the exact requirements of the application, IDD plates are manufactured in both short and long thermal lengths. This is accomplished by varying the angle of the "V's" in the herringbone pattern. The plate features a flat "W" chevron which produces extremely high turbulence, and high heat transfer at the expense of higher pressure drop. The steep-angled "V" pattern with correspondingly lower heat transfer and pressure drop.

Heat exchangers use the parallel flow pattern. Fluid in a circuit enters and exits on the same side of the heat exchanger. This means that the plates may be used as either left or ight plates simply by turning the 180°. Fluid runs from port 1 to port 4 and from port 3 to port 2.

CONSTRUCTION OF THE PLATE

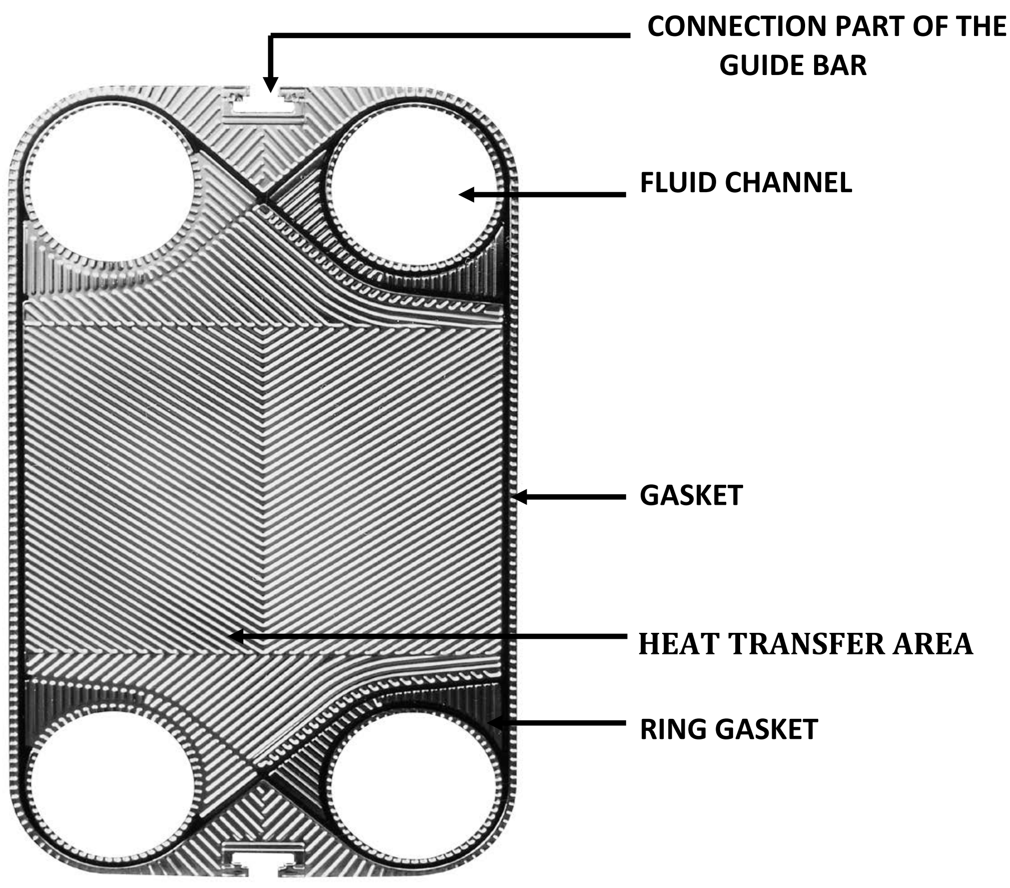
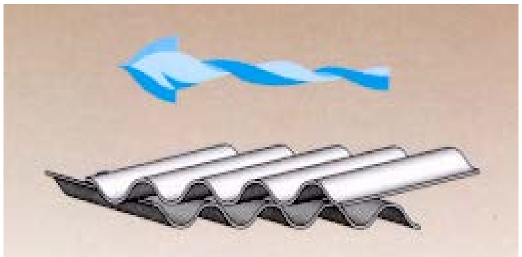
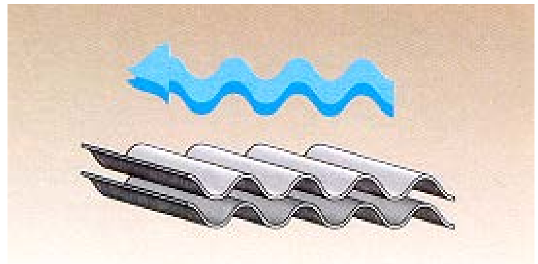


Fig. 1 PLATE
(MAIN FEATURES OF A HEAT TRANSFER PLATE)



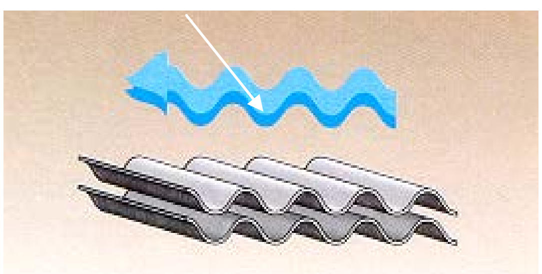
HERRINGBONE



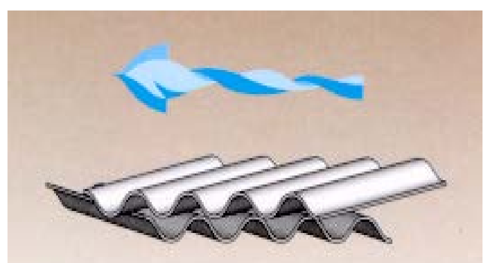
CORRUGATED

PLATE CHARACTERISTICS

Plate thickness is normally in the range 0.6-1.0mm. Stainless steel, Titanium, Hastelloy, Copper-Nickel and Al-brass are available.
The plates are pressed to form corrugations which increase the surface area and strength of the plates.
The plate has up to four connection holes for fluid transfer, with gaskets fitted to confine the liquids.
Gaskets are made from composed rubber and are chosen in accordance with the types of fluids to be used in the PHE. The corrugated shape on the plates maximizes the heat transfer efficiency by creating high turbulence in the channels.
Centrally located cutouts on the top and bottom ends of each plate is designed to make the plate hang correctly either side to the top and bottom guide bars.



CORRUGATE



HERRINGBONE

The gasket materials are normally NBR, EPDM, or VITON®. The gasket material is selected for compatibility with the fluids being processed and the operating temperatures. Gaskets are normally bonded in the gasket groove by means of a thin layer of adhesive. This adhesive is meant only to keep the gasket in place during opening and closing of the unit. It does not provide any sealing advantage. Many plates are available with the patented "Press-Tite" glueless gasket system. These gaskets are made to be pressed into place without any tools. A start gasket (used as the first plate in the pack) and a normal channel plate gasket are illustrated.

D. Gasket Design

The gaskets are designed as a duplicate structure to prevent mixing the fluids.
Should the ring gasket fail the liquid vents to the atmosphere (‘B’ part), and is prevented from mixing with the opposing liquid by the diagonal gasket.

In a similar manner if the diagonal gasket fails the ring gaskets acts as a secondary seal

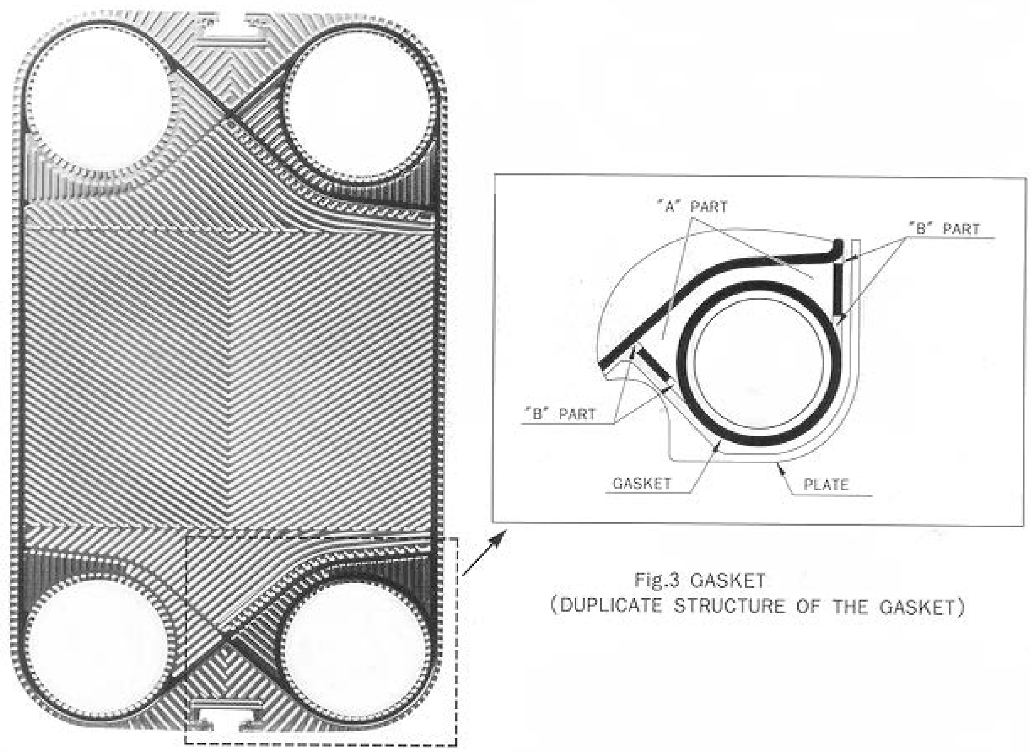


Fig.3 GASKET
(DUPLICATE STRUCTURE OF THE GASKET)

FLUID FLOW ARRANGEMENT “A” to “B” CONFIGURATION

Forming of the plate pack channels is accomplished by hanging the plates (gasketed plates should be faced to the frame) in alternative “A” then “B” fashion.

As can be seen in Fig.6, the plate which has the ring gasket on the left hand side plate hole is called the 'A' plate and when rotated becomes the 'B' plate. One fluid flows on the surface of each of the 'A' plates, while the alternative fluid flows over the 'B' plate.

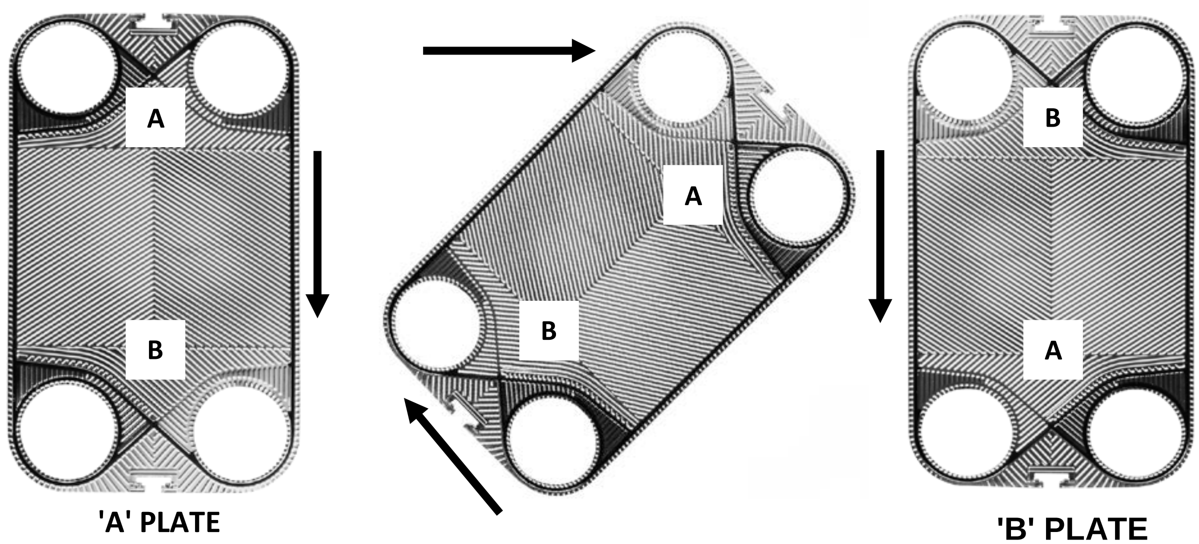


FIG: 6

The flow directions are normally counter current to each other. The hot fluid flows with two parallel lines, top to bottom and bottom to top, and the cold fluid with 4 parallel lines flows bottom to top.

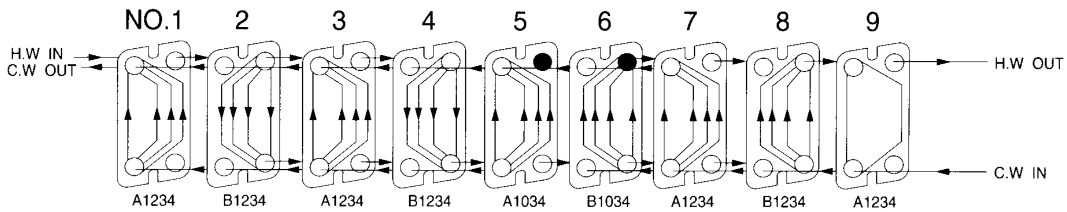
The plate arrangement can be written as $\frac{2 \times 2}{4 \times 1} + 1$

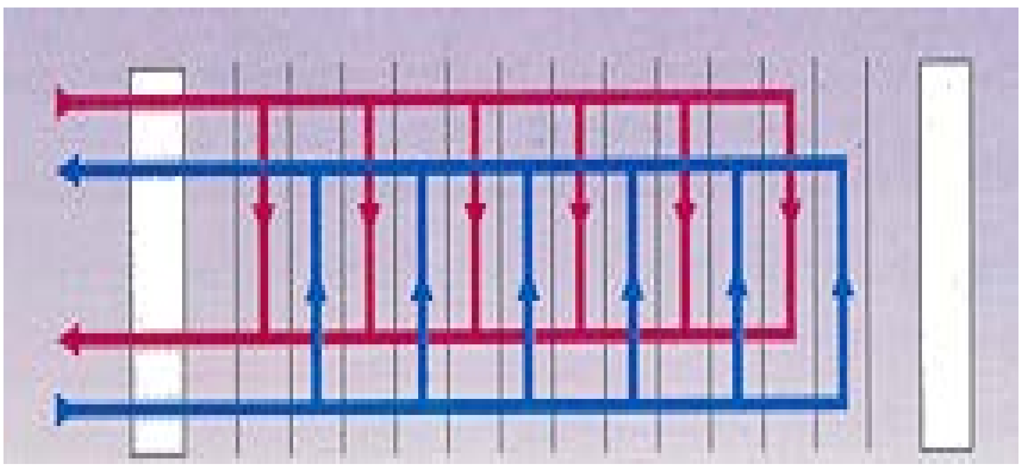
where + 1 represents the end plate which does not perform any heat transfer.

The four holes in the plate are distinguished as 1, 2, 3, and 4 from their positions, and '0' means no hole.

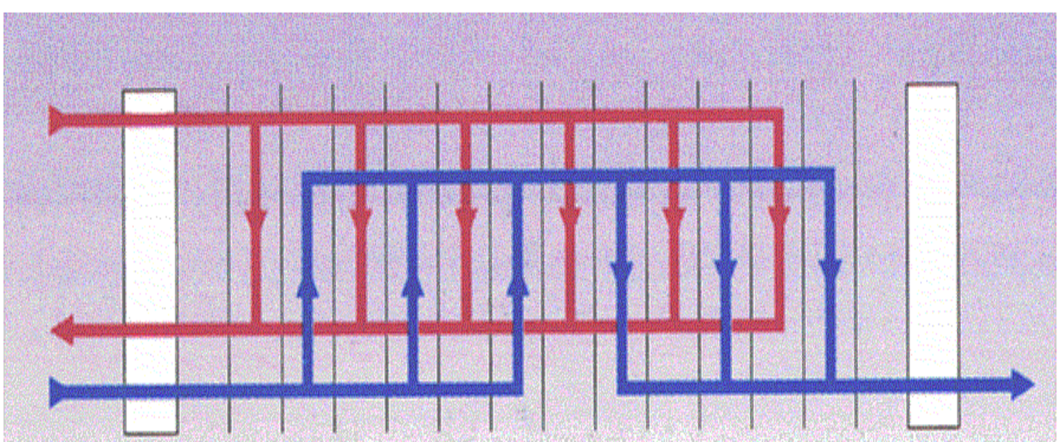
There are 16 hole combinations possible depending on the application and temperature approach.

EXAMPLE OF PLATE ARRANGEMENT AND FLOW



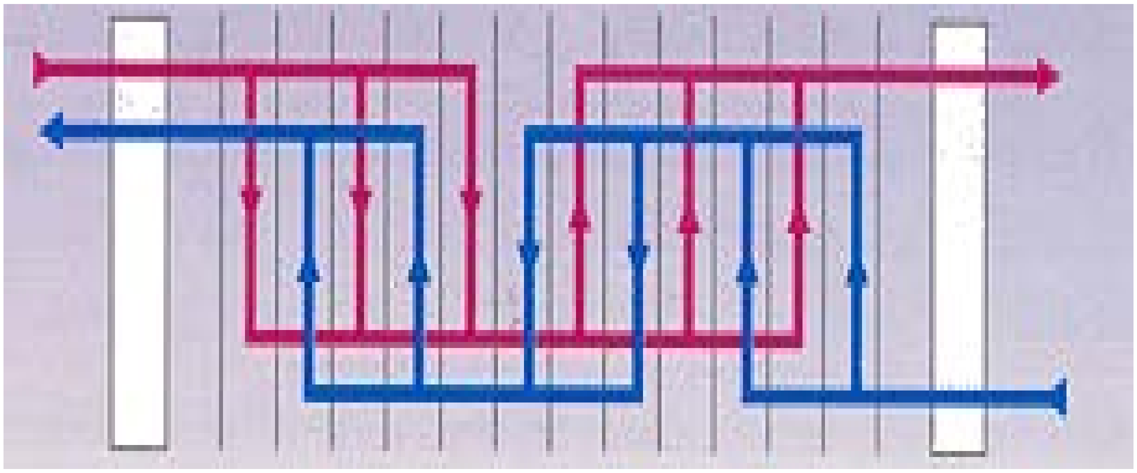


SINGLE PASS ARRANGEMENT

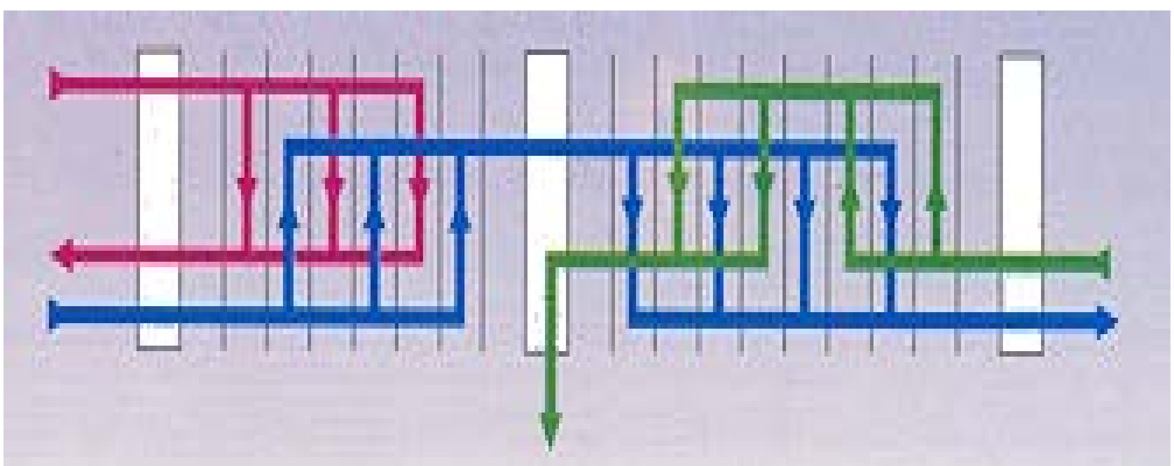


SINGLE AND MULTI PASS ARRANGEMENT

ADDITIONAL PLATE ARRANGEMENTS



MULTI PASS ARRANGEMENT



SINGLE & MULTI- MULTI PASS ARRANGEMENT

E. Installation

The IDD plate heat exchanger is pressure tested in accordance with the design calculation before delivery, and is ready for installation. The heat exchanger should be mounted in an upright position. Make sure you have enough space to open the heat exchanger for inspection or repairs without problems.

Space should be provided at the sides and ends of the heat exchanger to allow work to be carried out. The following recommendations should be followed when piping the unit:

- Piping should be connected according to the design calculation and drawing.
- Pipes should be fitted so that thermal expansion does not affect the heat exchanger or the fitting.
- Flexible connectors or stain-relief piping design may be used.
- Pipe supports should be located close to the exchanger so that the piping and related valves and fittings do not put tensions on the connections.
- A pipe connections to the exchanger should be fitted with shut-off valves so that the unit may be serviced without draining the system.
- If the pumps maximum pressure (zero-flow condition) is grater than the heat exchanger's working pressure, a safety relief valve should be installed at the inlet port.

  WARNING! NEVER ON THE OUTLET

F. Start-Up

When starting up a plate heat exchanger for the first time, observe the following procedures:

- Check that the plate pack dimension is within the limits specified.
- Make sure the piping system is cleaned to prevent entrance of gravel, sand, welding flux, etc. Into the heat exchanger.
- Open the heat exchanger outlet valves.
- Close the pump discharge valves (or HX inlet valves).
- Start the pumps and slowly open the pump discharge valves.
- When both sides are at full pressure, vent the heat exchanger. Trapped air will reduce the heat transfer and increase pressure drop.
- Examine the unit for any leakage . Minor leakage may stop when the unit reaches operating temperature and pressure.
- Do not exceed the maximum working pressure.

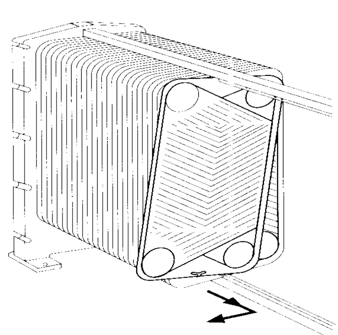
G. General Maintenance

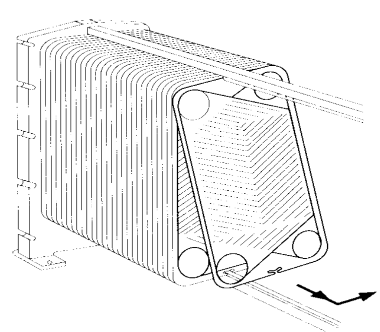
- It is recommended that tightening bolts, and tightening nuts be lubricated periodically in order that they can be easily loosened at time of disassembly.
- Check for loose tightening nuts. Temperature and pressure changes in the system may cause the plate pack to shrink. Re-tighten to specified dimensions.
- The upper carrying bar and lower guiding bar should be coated with a lubricant to enable the plates to slide smoothly.

H. Dismantling and Re-Assembly

- Before opening the heat exchanger, make sure that both sides are gradually lowered to atmospheric pressure.
- The temperature should be allowed to fall to ambient to avoid loosening the gaskets.
- Loosen the tightening bolts. The moving frame can now be pulled back towards the column, thus exposing the plate pack.
- The plates should be removed one by one if required.
- Dismantling of the plate pack must be carried out with great care. If not already done, number the plates before taking them out. To remove a plate from the frame, lift and tilt to an angle until it can be removed. If desired, the plates can be cleaned or inspected one by one while separated in the frame, and need not be removed.
- Before re-assembly, make sure that all plates and gaskets are wiped clean and free from dirt. Solid particles adhering to the gaskets can cause damage and may also result in leakage when the unit is put back in operation.
- Upon completion of cleaning and final inspection of each plate, the unit may be closed and tightened.
  - Never allow the pressure plate to be at an angle to the plate pack as the plates maybe distorted, due to excessive loading.

CAUTION! plates may have sharp edges. gloves should be worn during disassembly and assembly.





RE-ASSEMBLING THE UNIT

The first plate is the “A” plate followed by a “B” plate, until all plates are hanging in the frame.

Re-assemble the unit in the opposite sequence of disassembling see bolt tightening sequence below

TIGHTENING PROCEDURE

- Push moveable follower to contact rear of plate pack.
- Install tightening bolts and nuts.
- Starting with the center bolts, tighten using hand tools. It is important to keep the follower parallel to the fixed head during the entire tightening operation.
- Larger units will require power tools (i.e. pneumatic wrench) to tighten further.
- When the required measurement has been reached at the center of the pack, continue tightening the bolts out from the center. Do not tighten any particular bolt more than ½” at a time. Continue until frame is parallel and tightened to no more that the recommended tightening measurement.

WARNING!

The recommended tightening measurement is a minimum value which should not be exceeded. Permanent plate deformation may occur if the pack is over tightened. A unit may be shipped from the factory with a plate-pack measurement greater than the value. This is due to manufacturing tolerances and is normal.

I. Cleaning

It is not usually necessary to open the heat exchanger for cleaning until there is a decrease in thermal transfer or an increase in pressure drop. If cleaning is indicated, it may be done either manually (by opening the unit) or it may be cleaned-in-place (CIP).

MANUAL CLEANING

- Open the heat exchanger according to the dismantling instructions.
- Pull the plates apart from each other. Leave the plates in the frame if possible. If the plates are removed from the frame, mark them with numbers so you are able to replace them easily.
- Use a soft brush and a recommended cleaning agent.
- A high-pressure washer may be used if care is taken not to loosen the gaskets.

- Do not use wire brushes or any other abrasive material on the plates.
- Rinse the cleaning agent from the plate with fresh water immediate after cleaning.

FOULING	**CLEANING AGENT**
Organics	Alkine detergent (chlorine free - 2% caustic soda @ 120 to 160°F)
Fats/Oils	Kerosene
Calcium buildup	5% nitric acid or 2% sodium trimetaphosphate

CLEANING-IN-PLACE

- CIP is recommended when corrosive or hazardous liquids are being processed.
- Drain both sides of the PHE.
- Backflush both sides with warm water until the water flows clear. The rate should be at least 1.5 times the normal rate.
- If steam is used for cleaning, be certain that its temperature does not exceed the limitations of the gasket material (NBR/230ºF,EPDM/302ºF).
- A mild detergent or weak acid may be used. Be sure to flush with water when done.

CAUTION! Nitric acid and caustic soda may cause injury to exposed skin, eyes, and mucous membranes. The use of protective eyewear and gloves is strongly recommended.

J. Regasketing (glued in type)

- Remove the old gasket from the gasket groove using screwdriver if necessary.
- If the gasket does not come out easily, use mild heat on the back of the plate.
- Remove all of the old glue in the gasket groove. Methylethyl ketone or acetone may be used.
- Apply a thin coat of glue in the gasket groove.(Recommended adhesives are Pliobond-20, Scotchgrip 1099, or factory-approved equal)
- Press gasket into place, starting at the ends and working towards the middle of the plate.
- Stack the plates horizontally and put a heavy weight on top of the stack.
- Leave staked for approximately 12 hours before reinstating.

K. Troubleshooting

EXCESSIVE TEMPERATURES

The normal maximum operating temperature for a plate heat exchanger is approximately 250°F (120°C). Higher temperatures may be reached with special gasket and adhesive materials.

Operating any plate heat exchanger at temperatures above the design temperature of the gasket material will result in gasket and adhesive failure.

An excessive temperature gasket failure is indicated by a hard, shiny-surfaced gasket face. Quite often, these gaskets are so brittle they are cracked and can be crumbled with the fingers.

Points to look for are:

a. Excessive hot-side fluid or steam temperatures.
b. Unit being operated under conditions for which it was not designed.
c. Superheated steam.
d. Cold fluid stoppage on units operating at upper gasket temperature limits.

Corrective measures should include checking for excessive operating temperatures and lowering where needed or replacing with higher temperature gaskets.

If the unit is being used for services other than those for which it was designed, the necessary adjustments or gasket replacement should be done to ensure gasket compatibility with the operating temperature.

SUPER HEATED STEAM

Quite often high pressure steam is put through a single reducing station without going through a desuperheater. The steam is now at a lower pressure while still retaining much of its previous high pressure temperature. This, will have a very detrimental effect upon gaskets and greatly reduces the overall performance of the heat exchanger because of the decreased availability of latent heat while steam is in the superheated state.

Plates and gaskets will generally be at a temperature between the hot and cold fluids. Intermittent cold flow conditions can cause problems in units operating at borderline temperature conditions.

As the cold flow is interrupted, the unit will begin to come up to the temperature of the hot fluid and damage gaskets if upper temperatures are exceeded.

This can be alleviated by ensuring a constant cold-side flow or by throttling down the hot side during flow interruption.

EXCESSIVE PRESSURE AND SPIKES

The normal maximum operating pressure range for a plate heat exchanger is generally 150 to 235 PSIG (10 to 16 bar) for ASME-code units. ASME units require ASME relief devices per UG-125 of ASME Code, Section VIII, Div. 1, Preventing Excessive Pressure. However, plate heat exchangers which can operate at pressures up to 370 PSIG (25 bar) are available.

DESIGN PRESSURE

Operating a plate heat exchanger above its design pressure will result in gasket sealing problems.

These problems vary depending on the type of plate being used but are most often indicated by protruding gaskets which will extrude between plates and be visible on the perimeter of the plate pack. Leakage may or may not be present; but in either case, steps must be taken to correct the situation.

Excessive pressure must be reduced to limits within the design pressure of the unit or as the process parameters require. All regulating and throttling valves are to be placed on the inlet side of the plate heat exchanger.

Excessive lengths of piping being stopped by valves on nozzle outlets can cause tremendous “dynamic head” pressure on gaskets; this is to be avoided at all times.

PRESSURE SPIKES

Pressure spikes can also cause extremely high pressures. Some of the causes are totally closed systems without allowances for expansion, booster-pump start-up, and rapid-acting control valves.

When these conditions exist, they should be handled with vented closed systems, slow acting control valves, and accumulators whenever possible.

Negative pressure (vacuum) on a standard-design plate heat exchanger may also result in gasket leakage problems. A plate heat exchanger must never be subjected to vacuum (unless designed for vacuum application) during normal operations or during start-up and shut-down procedures.

FLUID INCOMPATIBILITY

This is evidenced by swelling of gaskets upon unit opening, tacky or liquid surface to gaskets, and gaskets failing off plates.

Advice should be obtained from factory personnel whenever these conditions are encountered.

Quite often, minute quantities of tramp contaminants in the fluid can have a large effect upon some elastomers.

Fluid sample testing and gasket coupon testing of various elastomers in the customer's process fluid can determine the proper compound to use.

In extremely difficult cases, a dual gasketing system using two different gasket materials on the fluids may solve the problem.

LEAK DETECTION AND ELIMINATION

Because of vented areas between portholes and plate faces, barring corrosion completely through plates, fluids cannot cross within the unit.

If any leakage does occur, it will be to the outside of the unit and observed as a slow leak.

If a unit starts leaking, check operating temperatures, pressures, and the overall plate pack dimensions.

When pressures and/or temperatures are in excess of design conditions, take measures to correct them and restart the unit.

If the above are within design conditions, allow the unit to cool to ambient temperature and relieve the pressure on all fluid circuits within the unit.

At this time, begin tightening the compression bolts in the prescribed manner but do not go below the minimum plate pack dimension by more than 1%.

If the unit still continues to leak, it may contain damaged or worn-out gaskets. Open the unit and individually examine gaskets for particulates, glue failure, or damage and wear. Remove those gaskets which appear to be have reached their life span and replace with new gaskets.

If there appears to be a problem with fluid crossing, that is, internal leakage; this indicates a condition that has been favorable for corrosion, causing cracks or pinholes through the plates.

The damaged plate or plates may be located by two methods for single-pass units:

Shut the unit down and relieve all pressure within the unit.

The piping on one side of the unit is now removed to allow viewing of the portholes for the length of the plate pack.

At this time, pressure is again turned on to the piped side, and leakage may be observed by shining a flashlight into the porthole to view and locate the leak.

With multiple-pass units, the above procedure will only allow partial viewing of the plate pack because of the non punched portholes in some locations.

In this case, the unit is opened and all plates are either wiped dry or allowed to air dry.

The compression bolts are then replaced, and the unit is re-tightened to the plate pack minimum dimension.

One side only is now pressurized for approximately 15 minutes.

Pressure is then relieved and the unit is now reopened. Carefully separate the plates one at a time, going from movable frame to fixed frame.

It will be noticed that every other flow channel is wet with a dry channel in between.

When you find two adjacent wet channels, you have located the affected plate. It will be one of the two plates in the centre.

Once the suspected leaking plate is located, you may confirm with visual inspection or dye penetrant techniques.

If the plate at fault is punched 1-2-3-4, the unit may be rapidly put back on line by removing an adjacent plate with the same punching.

Heat transfer will be reduced only to a minor extent.

If this punching arrangement is other than above, you will have to remove and replace the faulty plate(s) before restart.

Always reduce the plate pack dimension when removing plates by the thickness of the gasketed plates.

The amount of reduction in the "Q" dimension necessary for each plate removed may be obtained by using the multiplier shown on the data plate.

L. Spare Parts

Spare parts may be ordered directly from IDD. Plates and gaskets may be ordered separately, or the plates may be ordered with gaskets already glued in place. When ordering, please have the following information:

- Model number
- Serial number
- Plate material
- Gasket type and material

If you have any difficulty in identifying your heat exchanger, call IDD or your local representative for assistance. We will have your unit on file and will be able to help you in identifying the spare parts.

SPARE PARTS NUMBERING SYSTEM

All parts are created by the application of either an alpha / numeric or numeric code system.

A part number can be created for any gasket, plate with gasket or frame component by applying the appropriate code.

Ask your plate heat exchanger representative for detailed part numbers for your particular unit.