

GASKETED PLATE HEAT EXCHANGER

INSTALLATION OPERATION and MAINTENANCE MANUAL

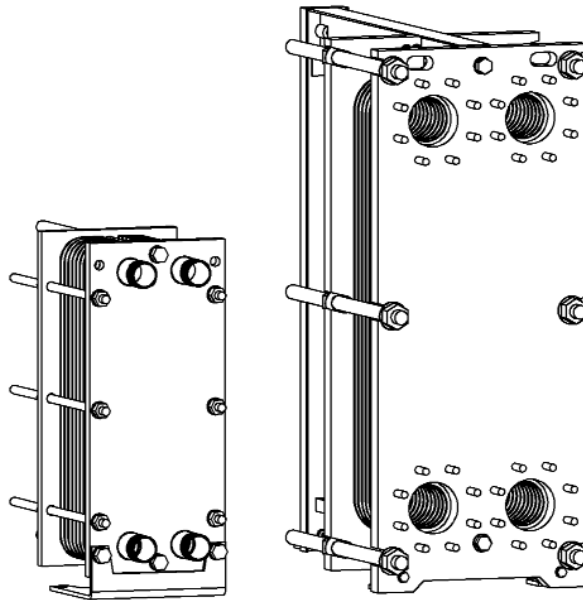


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PRODUCT & SAFETY

1.1 DEFINITIONS

The following terms are used throughout this manual to bring attention to the presence of potential hazards or to important information concerning the product.

DANGER

Indicates the presence of a hazardous situation, which if ignored, will result in death, serious injury or substantial property damage.

WARNING

Indicates a potentially hazardous situation, which if ignored can result in death, serious injury or substantial property damage.

CAUTION

Indicates a potentially hazardous situation, which if ignored may result in minor injury or property damage.

NOTICE

Indicates special instructions on installation, operation or maintenance, which are important to equipment, but not related to personal injury hazards.

NOTICE

Read all instructions included in this manual before installing and operating the heat exchanger. Failure to comply could result in severe personal injury, death or substantial property damage.

NOTICE

When calling or writing about the heat exchanger, please reference the heat exchanger model number and serial number located on the rating plate.

NOTICE

Installer should consider piping and installation when determining heat exchanger location.

NOTICE

Any claims for damage or shortage in shipment must be filed immediately with the transportation company by the consignee.

NOTICE

Triangle Tube reserves the right to modify the technical specifications and components of its products without prior notice.

1.2 PRODUCT RESTRICTIONS

Operating Restrictions

- Maximum working (design) pressure is 150 psig
- Maximum working (design) temperature is 250°F
- Minimum working (design) temperature is (-)20°F

Code Restrictions

Single wall heat exchangers comply with the National Standard Plumbing Code, provided that:

- The heat transfer medium (including additives) is practically non-toxic, having a toxicity rating or Class of 1 as listed in Clinical Toxicology or Commercial Products
- The heat transfer medium is limited to maximum 30 psig by approved relief valve.

Single wall heat exchangers are permitted under the Uniform Plumbing Code - Paragraph L3.2 if they satisfy all of the following requirements:

1. The heat transfer medium is potable water and contains only substances, which are recognized as safe by the U.S. Food and Drug Administration.
2. The pressure of the heat transfer medium is maintained less than the normal minimum operating pressure of the potable water system.
3. The equipment is permanently labelled to indicate that only additives recognized as safe by the FDA shall be used in the heat transfer medium.

Or, per Uniform Plumbing Code paragraph L3.3 as follows:

Other heat exchanger designs may be permitted where approved by the Administrative Authority.

GENERAL

2.1 DESCRIPTION

A Triangle Tube Plate Heat Exchanger consists of a plate pack of thin metal plates especially designed to transfer heat from one fluid to another. These thin metal plates are separated and sealed by a set of rubber gaskets that provide the desired distribution of the fluids through the plate pack. The plate pack is installed in a frame, which provides the nozzles for the fluids, and the proper compression of the plates by means of a set of tightening rods.

2.2 FRAME

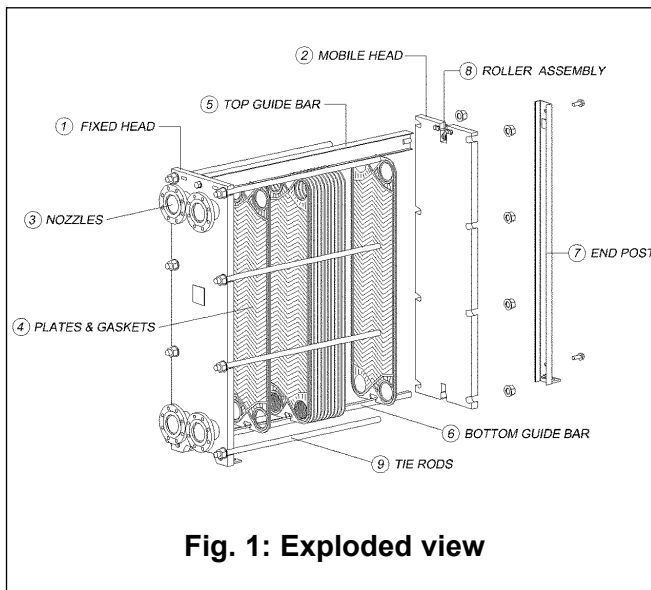


Fig. 1: Exploded view

2.2.1 TYPICAL FRAME COMPONENTS

(1) Fixed Head and, (2) Mobile Head

Made of thick, rigid, pressure-vessel quality steel plates. They are used to compress the plate pack.

(3) Nozzles

There are three types of nozzles :

- NPT Nipples: for Model TT20 and smaller, size from 1" to 2 1/2". Rated from Sch40 to Sch80.

- Studded ports: for Model TT28 and larger, size to fit 4" ANSI flanges and up, rated from 150# to 300 #.
- ANSI flanges: available for all models. Size to fit 4" ANSI and larger, rated from 150# and 300#, slip on, lap joint and weld neck.

Standard exchanger consists of one inlet and one outlet for each flow. Special designed exchangers could have more than 4 nozzles with different types on different ports. See section 2.2.3 for nozzle terminology

(4) Plates and Gaskets

See section 2.3 Plates and Gaskets for detail.

(5) Top Guide Bar and (6) Bottom Guide Bar

Attached to the fixed head and the end post. It supports the plate pack and mobile head allowing easy disassembly of the exchanger for maintenance.

(7) End Post

Available on Series FF, FS and FN for full support. Keeps the exchanger in rigid position.

(8) Roller Assembly

Installed on mobile head of Model TT28 and larger, helping the movement of Mobile Head along Top Guide Bar during assembly of the exchanger.

(9) Tie Rods

Evenly spaced around the periphery of the exchanger to clamp the plate pack between the fixed and mobile head. Hydraulic cylinders may be used for tightening and loosening of the plate pack.

2.2.2 FRAME SERIES

Triangle Tube frame types are titled with two or three letters. The first letter indicates the type of footprint, the second letter indicates the type of nozzles and the last letter indicates frame revision number.

The first letter: F: With end post
 P: Without end post
 The second letter: S: With studded port nozzles
 N: Threaded nipple nozzles
 F: With flanged nozzles

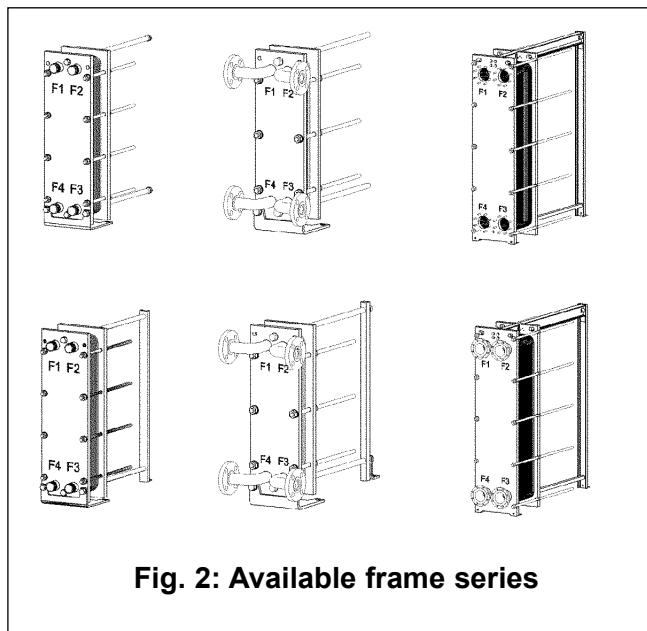


Fig. 2: Available frame series

2.2.3 NOZZLES TERMINOLOGY

The nozzle locations in the frame heads are identified using the following convention of a letter followed by a number:

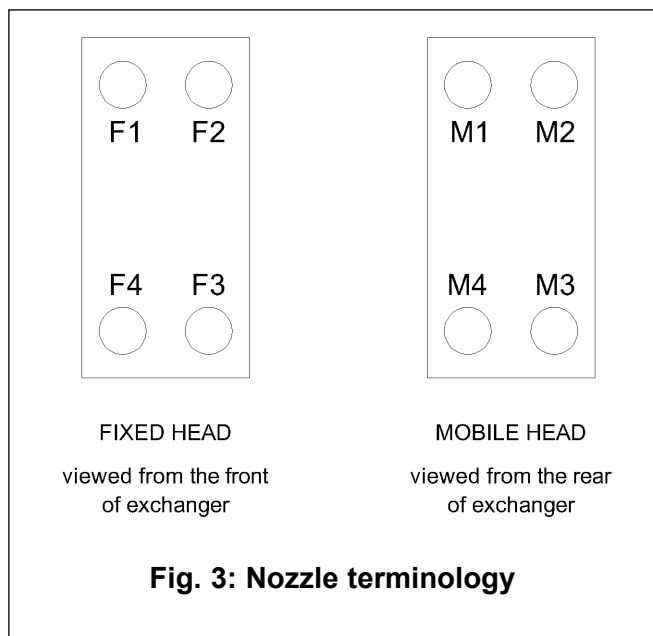


Fig. 3: Nozzle terminology

2.3 PLATES & GASKETS

2.3.1 THE PLATE PACK

The design conditions of each plate heat exchanger is stamped on the exchanger's nameplate and shown a general arrangement drawing. At no time should the exchanger be operated under conditions that exceed those listed on the nameplate.

The General Assembly Drawing, (available upon request) provides all of the information regarding the composition of your plate pack. However, the following conventional rules must be observed when performing maintenance work to your exchanger:

- All plates have the letters "N" and "S" stamped at opposite ends to assist in orienting them correctly during hanging.
- The plates are referred to as EVEN PLATE or ODD PLATE depending on the orientation of their gasket with respect to the N and S ends, and the ports that it blocks off.
- ODD and EVEN plates control the orientation of flow of the fluids in the exchanger (See figures 7 and 8 for details.)
- ODD PLATES (3,5,7...) by convention are installed with the letter "N" at the top. EVEN PLATES (2, 4, 6...) are installed with the letter "S" at the top.
- The first, last and pass plates are considered SPECIAL PLATES and are installed with the letter "N" at the top.

2.3.2 PLATE CORRUGATION PATTERNS

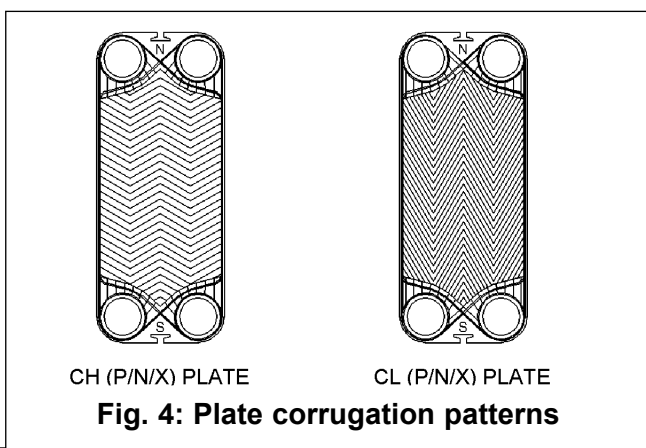
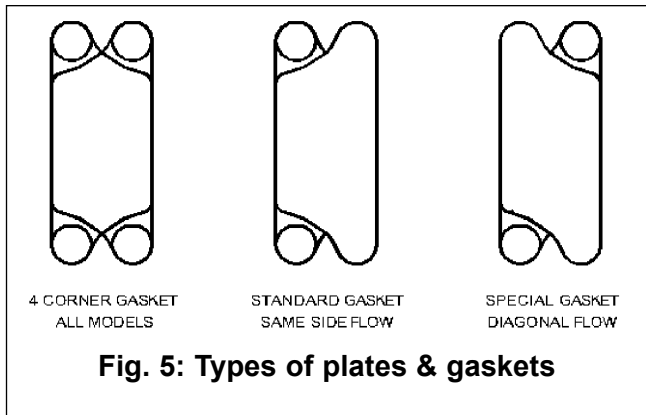
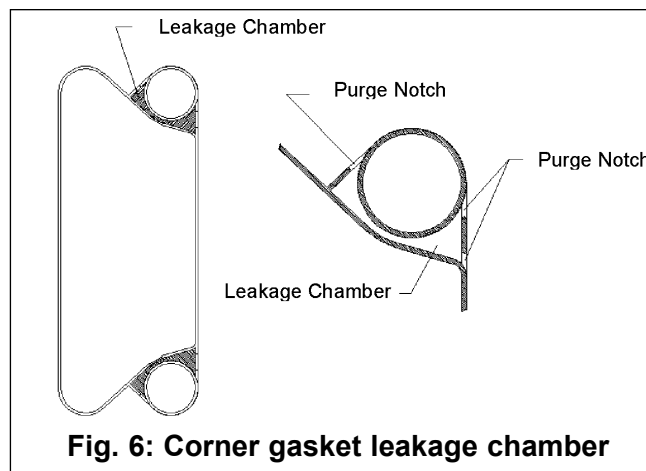


Fig. 4: Plate corrugation patterns



NOTICE

- The first plate is equipped with a special 4 CORNER GASKET which isolates the four ports, preventing fluid passage between the first plate and the fixed head.
- All other plates are equipped with standard gaskets.
- Multi-pass units are supplied with one or more port gaskets (Ring gaskets) which are glued in place on the reverse side of the last plate.
- Port gaskets are also used in exchangers with nozzles in the mobile head, such as multi-pass or triple fluid units.
- All gaskets have a double safety feature to prevent fluid intermixing. The isolated port has a double retaining gasket, which forms a leakage chamber. This leakage chamber is connected to the atmosphere by three notches in the gasket. (See Figure 6)

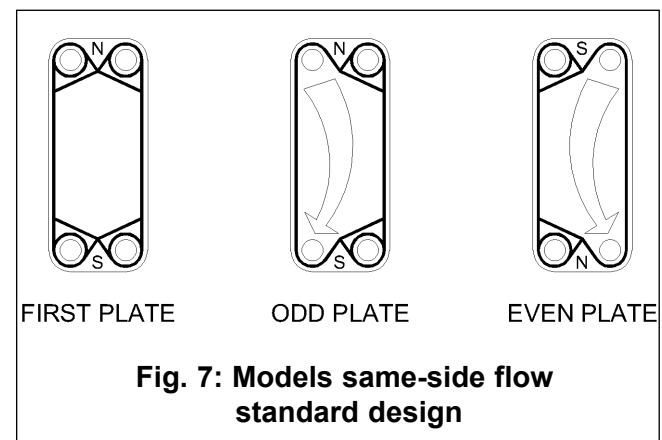


2.3.3 GASKETED PLATES

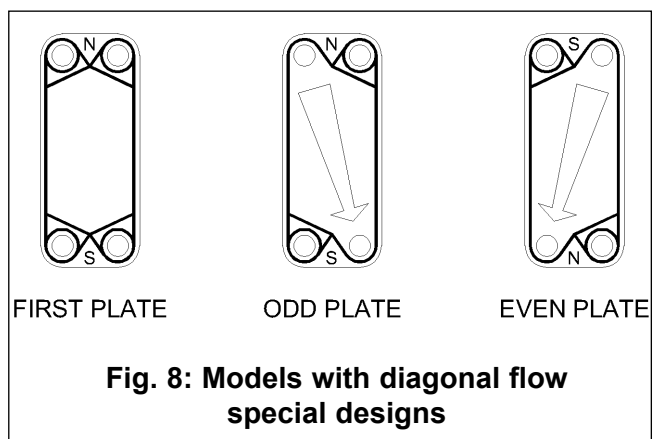
A standard plate is classified as ODD or EVEN depending on the orientation of the ports isolated by the gasket and the location in the plate pack with reference to the fixed head.

- ODD plates mounted "N" side on top.
 with port F2 isolated by gasket.
- EVEN plates mounted "S" side on top.
 with port F1 isolated by gasket.

Model-Same Side Flow: ODD and EVEN plates are physically identical, thus could be interchangeable by hanging in opposite direction. (See Figure 6 below.)



Model-Diagonal Flow: ODD and EVEN plates are different from each other and are not interchangeable without replacing the gaskets. (See Figure 8 below.)



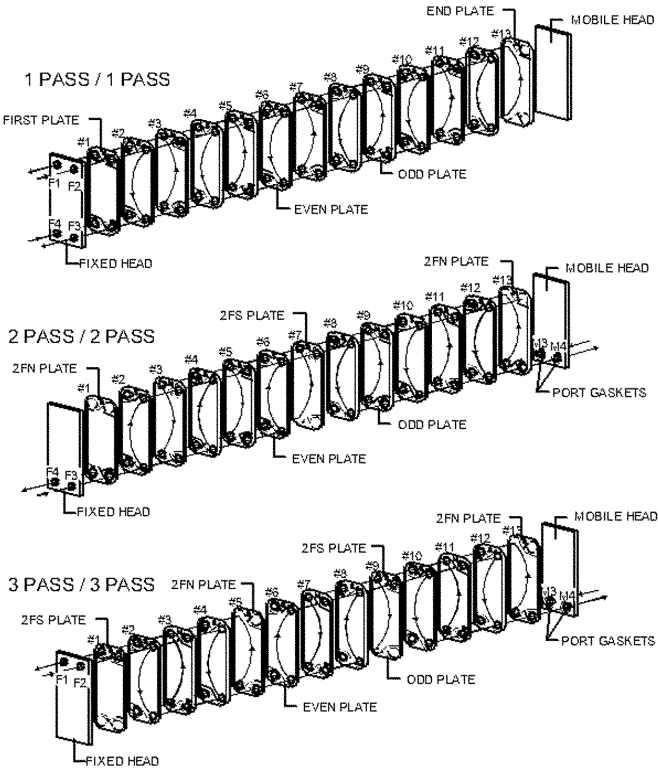


Fig. 9: Same side flow - Typical pass arrangements for all standard models

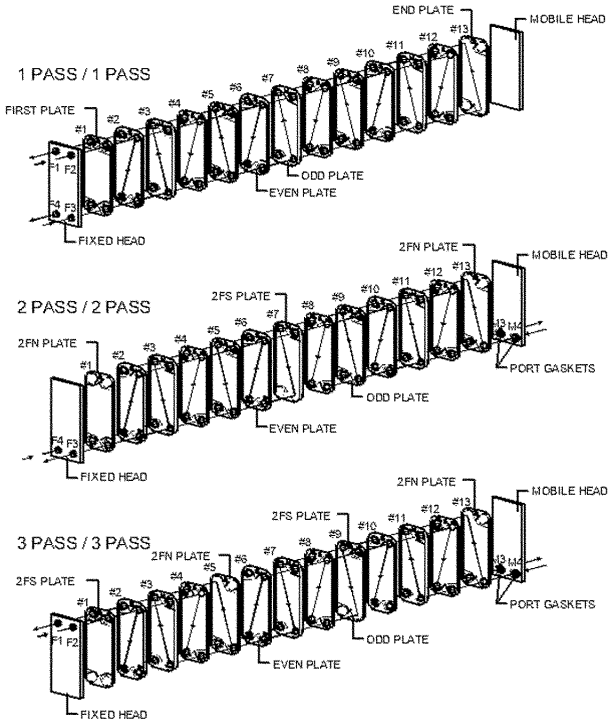


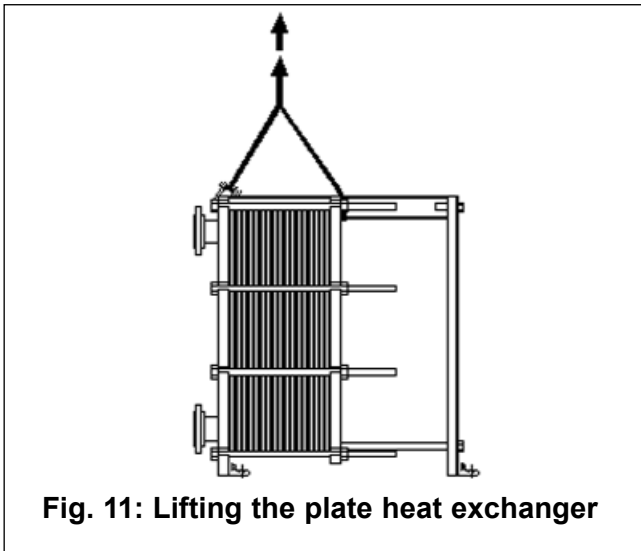
Fig. 10: Diagonal flow - Typical pass arrangements for special models

INSTALLATION

Triangle Tube Plate Heat Exchangers are delivered pre-assembled and tested. The exchanger should be rigidly fixed on the floor by means of anchor bolts.

3.1 LIFTING THE PLATE HEAT EXCHANGER

To lift the plate exchanger use the lifting holes provided in the fixed head and wrap the lifting cable around the upper guide bar next to the mobile head, as shown in Figure 11 below. Please note that exchangers with shrouds might require the removal of the shroud prior to lifting.



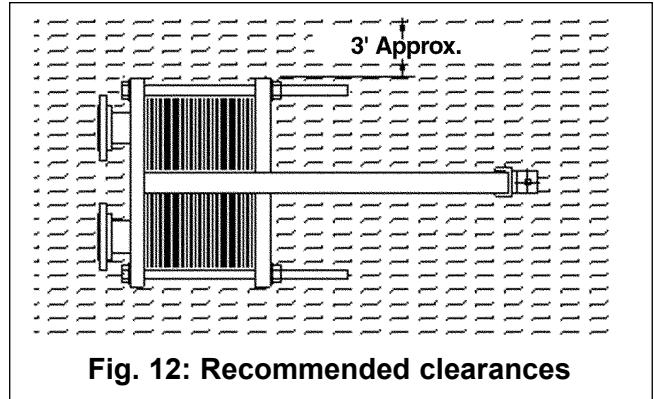
3.2 DRIP TRAY

A drip tray with a volume capacity of at least the capacity of the heat exchanger is recommended for exchangers operating with corrosive liquids.

3.3 INSTALLATION AND PIPING

The following steps are recommended for the correct installation of the heat exchanger:

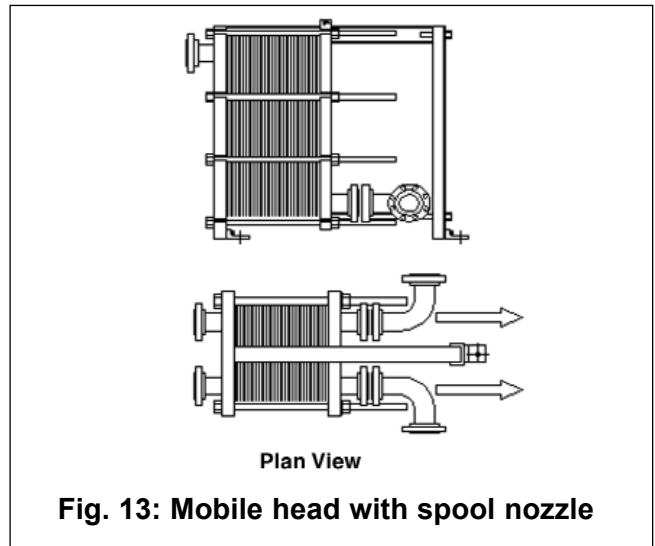
- Locate the exchanger in an area not congested by piping or other equipment.



NOTICE

All piping must meet or exceed all local, state and national plumbing codes and requirements.

- Provide approximately 3 feet (1 meter) of free space around the exchanger for easy maintenance.
- Ensure that the exchanger is level when installed.
- Allow expansion and flexibility in piping system. Thermal expansion in restricted piping can cause overloading of the heat exchanger nozzles, leading to leakage and/or over-stressing.
- Piping should be adequately supported to minimize misalignment or overloading of the exchanger nozzles.



- f) Nozzles located at the mobile head must be installed with spool pieces as shown in Figure 13, to allow the head to move fully backward.
- g) Isolation valves are recommended for all nozzles so that exchanger can be shut down and opened without disturbing adjacent systems. Quick action valves should be avoided to prevent water hammer.

Pressure control valves (when installed) should be located at the inlets to the exchanger. Positive displacement.

CAUTION

Exchanger models TT20 and smaller are provided with alloy insert nozzles, which are not welded to the frame. The nozzles must be held in position with a wrench when connecting the exchanger to the piping system. Failure to comply will cause damage to the gasket between the nozzle inner face and the adjacent plate.

- h) Pumps sending fluids to the heat exchanger should be equipped with throttling valves. Where the maximum pump discharge pressure might exceed the maximum working pressure of the exchanger, a safety relief valve should be provided.

3.4 STORING THE EXCHANGER

If it is necessary to store exchanger for an extended period of time, either before start up and/or after extensive maintenance and decommissioning, the following procedure is recommended:

- To avoid deterioration of the gaskets, protect the plate pack from UV radiation by covering it with a dark plastic sheet. Avoid storing the exchanger in a room with ozone generating equipment, such as electric motors, arc welding, etc.
- Apply a coat of rust preventative to all carbon-steel machined surfaces, such as bolts and flange faces.
- Cover over nozzles with wooden or metal covers, using rubber gaskets.

Nozzle Size		Fx (direct force)		Ft (radial force)		Mt (torsion moment)		Mf (bending moment)	
DN	IPS	N	Lbf	N	Lbf	Nm	Ft lbf	Nm	Ft lbf
50	2"	600	135	600	135	160	120	80	60
65	2 1/2 "	750	170	750	170	260	190	130	95
80	3"	1000	225	1000	225	300	220	150	110
100	4"	1400	315	1400	315	740	540	370	270
150	6"	2700	605	2700	605	1600	1180	800	590
200	8"	4400	990	4400	990	4500	3320	2200	1660
250	10"	5800	1300	5800	1300	7600	5600	3800	2800
300	12"	7000	1570	7000	1570	12000	8850	6000	4425
400	16"	8900	2000	8900	2000	20360	15000	10180	750

N = newton, Nm = newton meters, lbf = pound force, Ft lbf = foot pound force

Fx = resultant direct force on nozzle
 Ft = resultant radial force on nozzle
 Mt = resultant torsion moment on nozzle
 Mf = resultant bending moment on nozzle

Table 1 - Maximum allowable nozzle loads

INSTALLATION

3.5 ALLOWABLE NOZZLE LOADS

CAUTION

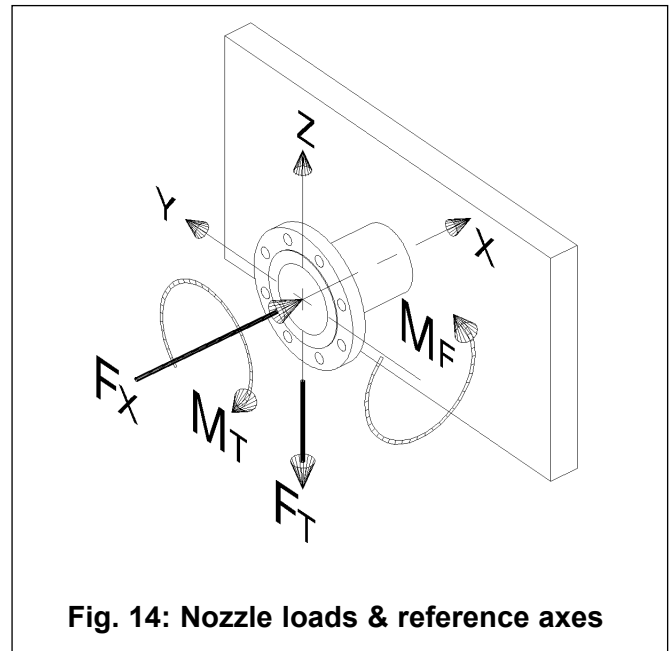
Care must be taken not to damage the nozzles of a heat exchanger. Damage can occur in a number of common ways that excessively push, pull or twist the nozzles.

- Ensure piping does not have means to allow expansion or has too much allowance, the piping can pull on or push against the nozzle, or twist the nozzle
- During installation, inappropriate use of a wrench on the nozzle can twist the nozzle
- An exchanger may be seriously damaged if its nozzles are used as lifting points, the installer must use lifting holes and the procedure given in 3.1.

CAUTION

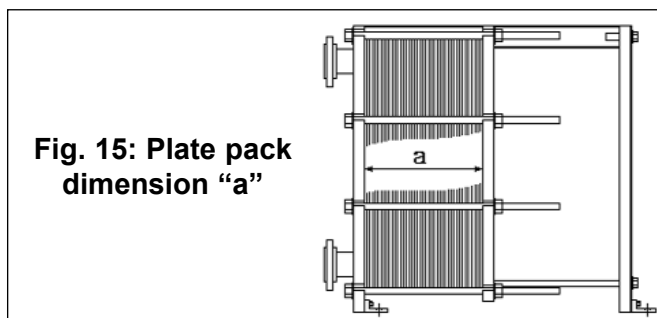
Ensure the system piping connected to the exchanger is secured to protect the exchanger against sudden pressure surges or temperature fluctuations.

Unless specifically allowed for in your heat exchanger's design, the maximum external nozzle loads should not exceed those given in Table 1 page 8. Please note that these values apply only to studded-ports and nozzles welded to the frame.



4.1 INITIAL OPERATION

- a) Make sure that the tightening dimension 'a' (distance between the inner faces of the fixed and mobile heads) is within the limits specified in the Plate specifications. See section 5.2.1 or 5.2.2 of this manual for tightening instructions.



- b) Ensure that the piping system connected to exchanger is free of scaling or any other foreign matter that will clog the plate pack. The exchanger can become fouled with solid particles of any considerable size.
- c) Make sure that all nozzles are properly fastened.
- d) Ensure that your system is maintained within the heat exchanger's design limits for temperature and pressure as allowed by the nameplate.

4.2 START-UP NON-STEAM APPLICATIONS

To start up the heat exchanger, complete the following steps beginning with the system circuit with the least severe operating conditions, and then repeat the procedure for the remaining system circuit.

- 1) Close the feed valve between the pump and exchanger.
- 2) Open fully the isolation valve at the outlet of the exchanger.
- 3) Open the vent valve at the exchanger.
- 4) Start the pump.
- 5) Slowly open the feed valve.
- 6) Close the vent valve when all air has been removed.

4.3 START-UP STEAM APPLICATIONS

The steam system circuit must be started up as the last system circuit and must be the first system

circuit shutdown when the exchanger is placed out of service. Do not operate the steam system while having the liquid system circuit inoperative.

Sudden opening and closing of the steam valves may deform plates to the point of being non-serviceable. Steam valves must be set to open gradually.

Start-up and shut down of the steam system circuit must be controlled to protect the exchanger from shocks. The amount of heating or cooling should be controlled using throttling valves in conjunction with process thermometers.

4.4 SHUT DOWN PROCEDURES

4.4.1 BRIEF SHUTDOWNS

If exchanger is to be shutdown for a short period of time, such as for inspection, service or pump stoppage, proceed as follows:

1. Slowly close the feed valves, starting with the system circuit with the most severe conditions.
2. Switch off the pumps for both system circuits.
3. Close the valves at the outlet nozzles.

4.4.2 EXTENDED SHUTDOWNS

For long-term shutdown of the exchanger (a period lasting more than one month), proceed as the steps as described above in the Brief Shutdown along with the following recommendations:

1. Vent and drain the exchanger.
2. Flush the exchanger plate pack and perform the appropriate cleaning procedure.

NOTICE

Ensure the plates are rinsed and free of any residual chlorine, either from the process fluids or the rinse water, since this can cause pitting of the plates.

3. Slacken the plate pack by 10 to 20% of the existing dimension 'a': ($a + 10$ to 20%). See Figure 15.
4. Refer to section 3.4 of this manual for proper procedures on storing the plate exchanger.

MAINTENANCE

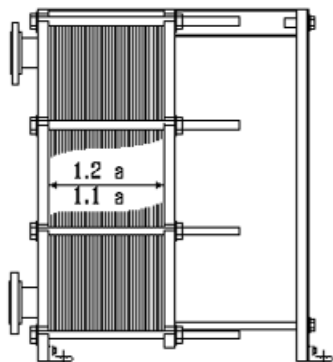


Fig. 16: Slackening the plate pack for storage

DANGER

The plate pack must be retightened to the original "a" dimension prior to proceeding with the Start-up procedures. Failure to comply will result in severe personal injury and/or substantial property damage

5.1 OPENING PLATE PACK

Prior to opening the exchanger plate pack, the contractor must ensure the following guidelines are completed:

1. Shut-down the exchanger as described per the procedures in Section 4.3.
2. Disconnect any nozzles on the mobile head (if applicable).
3. Clean the exposed section of the upper guide bar, to allow easy movement of the plates
4. Clean the mobile head roller so that it can move easily
5. Clean and lubricate the tightening rod threads
6. Record the current tightening dimension 'a'.
7. Paint a diagonal line across the side of the plate pack to facilitate the correct sequencing on re-assembly as shown in Fig. 17..

5.1.1 MANUAL OPENING

1. Release the tension on the tie rods in a diagonal pattern, alternating sides (e.g. top right followed by bottom left). Loosen each nut by only

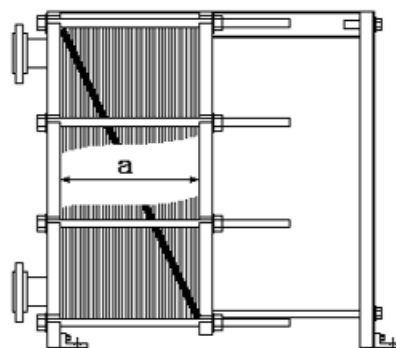


Fig. 17: Paint a diagonal line across the plate pack

1/4" to 1/2", and no more. It's important that the heads remain parallel to avoid damaging (crushing) the plates between them.

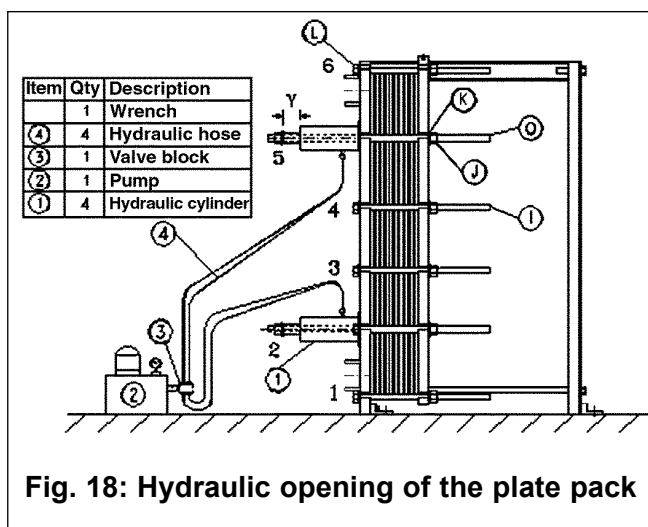
2. When all tie rods have been fully loosened, they may be removed. Push the Mobile Head fully away from the plate pack, up against the end post.
3. Remove the plates one by one and place on a flat surface.

WARNING

Plates contain sharp edges. Wear gloves and handle the plates with care.

5.1.2 HYDRAULIC OPENING

1. With a wrench, loosen the hexagonal nuts (Item J, Figure 18) from the two pairs of tie rods (Item 0) in positions 2 & 5 (also shown in Figure 18)
2. Loosen the four nuts (Item J) to a length corresponding to the opened length of the hydraulic cylinder.
3. Push the four tie rods (Item 0) forward toward the fixed head.
4. Mount the four hydraulic cylinders with rams extended to 6 mm (1/4") less than their full length of travel.
5. Put all cylinders under pressure. This will tighten the plate pack slightly, by about 6 mm (1/4").



6. Hold cylinders under pressure and remove the pair of tie rods in positions 3 & 4
7. Loosen the nuts (Item J), by ("Y" minus 6 mm (1/4")) on the remaining pair of tie rods in positions 1 & 6. The Y dimension represents the hydraulic ram travel distance (typically either 100 mm (4") or 150 mm (6")).
8. Release the pressure from the cylinders and allow the plate pack to expand against tie rod pairs in positions 1 & 6.
9. Repeat the above operations until the plate pack is fully opened.
10. The gaskets sometimes stick to the adjacent plate. In this case use a plastic or wooden wedge to carefully pry the plates apart.

CAUTION

Do not use a metal or sharp object such as a screwdriver to pry the plates apart. Damage can be result to the plates and gaskets.

5.2 CLOSING THE PLATE PACK

Prior to closing the exchanger the contractor should ensure the following has been completed:

1. Make sure that the plates and gaskets are free of foreign matter or contaminants. If necessary clean with a soft cloth or brush.

2. Clean the guide bars to ensure easy movement of the plates when reinstalling and tightening.
3. Install all the exchanger plates in the correct sequence as per the exchanger specification. If needed, a General Assembly drawing may be requested to assist in the re-assembly. The diagonal line on the plate pack side must be visible and appear as unbroken.

NOTICE

When closing plate packs with a very large number of plates (300+), allow the plate pack to relax for at least one hour after every 4 to 6 inches of displacement for the last 12" of tightening. This will help to prevent deformation of the plates closest to the covers by distributing the thrust force more evenly along the plates and gaskets. This is particularly important for plates made of softer metals.

CAUTION

If the exchange plate pack does not seal at the recorded tightening dimension 'a', further tightening is allowed. However, the following rule must be observed:

- Never tighten the exchanger while it is under pressure
- Never tighten the plate pack to a dimension smaller than the minimum dimension shown on the General Assembly drawing or as advised by Triangle Tube if the number of plates has been modified.

Failure to comply with these guidelines could result in permanent damage to the exchanger plates.

5.2.1 MANUAL CLOSING

1. Push the mobile head into contact with the plate pack.
2. For large units select and install a minimum of 50% of the tie rods, evenly distributed in the frame.

MAINTENANCE

3. Tighten the plate pack using diagonally opposite tie rod pairs, in a sequence similar to that given in Figure 19 below. Ensure during closing that the fixed and mobile heads are kept parallel to each other to within 1/4" to 1/2".
4. Install and tighten the remaining tie rods and ensure that all tie rods are under tension.
5. If the plate gaskets are reused, the tightening dimension should be between the recorded dimension "A" and the minimum tightening dimension given in the General Assembly drawing, provide the number of plates is unchanged. If new gaskets are used, the tightening dimension should be within the minimum and maximum allowable dimension given in the General Assembly drawing.
6. After final tightening, the fixed and mobile heads must be parallel to within 1/16" in all dimensions to ensure proper plate pack alignment.
6. Shut off the hydraulic pump, maintaining the cylinders under pressure.
7. Install the remaining tie rods and tighten them by hand.
8. Release the pressure from the hydraulic cylinders. When rams have fully retracted from the nuts, tighten the nuts against the mobile head.
9. Re-activate the hydraulic pump and repeat the procedure until the required tightening dimension is reached. If old gaskets are still used, the tightening dimension should be between the recorded dimension and the minimum tightening dimension indicated in the General Assembly Drawing (provided that the number of plates remains as per the original design). If new gaskets have been applied, then the tightening dimension should be no larger than the maximum specified on the General Assembly Drawing, and no smaller than the minimum specified.

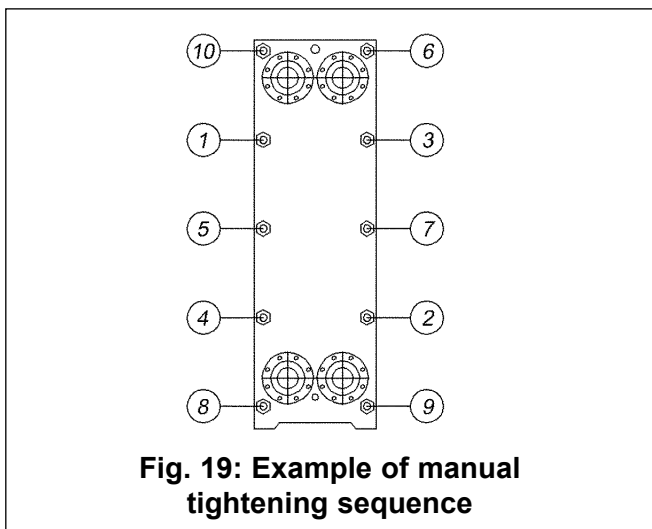


Fig. 19: Example of manual tightening sequence

5.2.2 HYDRAULIC CLOSING

1. Push the mobile head into contact with the plate pack.
2. Install the four tie rods (Item 0, Figure 18) and adjust them so that they project at least 18" out from the face of the fixed head, to allow installation of the hydraulic cylinders.
3. Mount the four hydraulic cylinders (fully closed) at the fixed-head end.
4. Install the nuts (Item L, Figure 18).
5. Activate the hydraulic pump and allow the cylinders to tighten the plate pack.

10. Finish tightening the tie rod nuts (Items L or J) with a wrench. The fixed and mobile heads must be parallel to within 1/16" in all directions, to ensure proper plate pack alignment.
11. Remove the hydraulic cylinders and tighten the four remaining tie rods.
12. The unit is ready for hydrotest.

5.3 RE-GASKETING

Triangle Tube plate heat exchangers, depending on model and materials of construction, are available with glued or glueless gasketing systems. Please consult Triangle Tube Engineering to verify the gasketing system used.

CAUTION

When replacing a significant number of gaskets, consider replacing the entire set. The sealing properties of gaskets under compression diminish over time, and this determines the amount of tightening that will need to be applied to the plate pack when closing the exchanger. Mixing of old and new gaskets, therefore, will cause over-compression of the new gaskets, severely reducing their service life.

5.3.1 GASKET GLUING

When gaskets are supplied loose for on-site installation, the plates must be properly cleaned and prepared, and the gaskets attached to the plates according to the following instructions:

PLATE PREPARATION:

Old gaskets and glue must be completely removed. If the removal of the gasket proves difficult, use a hot air gun to heat the gasket groove from the back of the plate. As the adhesive softens, pull the gasket off with pliers. As an alternative, the plates may be dipped in liquid nitrogen and then knocked; the gaskets should crumble off.

The gasket groove must be completely clean. Any remaining traces of old adhesive should be removed by rubbing with a non-abrasive cloth. If solid particles remain in the gasket groove, remove them carefully with an abrasive cloth.

GLUING THE GASKETS

It is recommended for cold gluing, the use of 3M's 3MEC1099 adhesive or its equivalent (the glue can be 1 or 2 parts).

CAUTION

Care must be taken not to scratch the gasket groove on the exchanger plate. Damage to the plate can result in leakage under the gasket.

NOTICE

For best results in gluing the gaskets, carefully follow the manufacturer's instructions for the glue that you select.

Prior to gluing, review section 2.3 Plates and Gaskets of this manual for a good understanding of the gasket terminology used in this manual, e.g. 4 corner gasket (4 Cr), and the standard gasket in odd or even position.

Perform a visual inspection and ensure that the gasket grooves are clean, and dry, and that there is no visible damage to the gasket groove.

Roughen the side of the gasket to be glued with an emery cloth or sand paper. Do not roughen the reverse side of the gasket.

The contractor should ensure the following guidelines are followed for proper gasket seals:

- The sealing edge of the fibre gaskets has not been roughened.
- For models using gaskets that have one side flat and one curved, the flat side is to be glued against the plate.
- Glue should be applied evenly in the plate's gasket groove with a tube, glue gun or small, round pure bristle brush.
- Use a minimum amount of glue, evenly applied over the entire gasket groove and roughened side of the gasket.
- Allow the glue to dry for about 5 to 10 minutes (refer to glue manufacturer's instructions). When the glue is tacky, carefully line up the gasket with the groove and press the gasket into place.
- Do not force or stretch the gaskets.
- To ensure proper seating, tap the gasket lightly into place with a soft faced mallet.
- Glue must be completely dry before the plate pack is placed into service.
- Stack the plates horizontally on a support that assures that the plates are centered. Ensure that the gaskets remain in the grooves.
- Place a uniform weight on the top plate and allow the pack to sit and dry per the glue manufacturer's instructions.

CAUTION

Ensure the glue is compatible with both the plate material and the gasket material. Consult with the glue manufacturer to ensure compatibility.

MAINTENANCE

5.3.2 GLUELESS GASKET REPLACEMENT

Triangle Tube's glueless gasket systems allows gasket to be snapped in place in the grooves on the plate perimeter.

Please contact Triangle Tube Engineering for additional instructions on Glueless Gasket Replacement, if required.

5.3.3 STORING SPARE GASKETS AND GLUE

It is recommended that spare set of gaskets be readily available for each heat exchanger in service. As a guideline for two years of operation, stock 10% of the total number of gaskets. Stock a complete set of gaskets if they are of special materials with long lead times.

Gaskets should be stored in an area sheltered from any sources of ultra violet light, such as fluorescent lights, or ozone generating equipment such as electric motors. Normal shelf-life for gaskets is about three years, but exposure can lead to premature deterioration. When storing in exposed areas, wrapping the gaskets in dark plastic is recommended.

Storage temperature should be maintained between 32 °F (0 °C) and room temperature to ensure ease of handling the gaskets. Whenever gaskets have been exposed to temperatures lower than recommended, they should be warmed to room temperature before handling.

Whenever practical, the gaskets should be stored flat. Large gaskets may be stored lightly folded in half, as long as any sharp bends are avoided, since these will cause the gaskets to crack.

It is advisable to stock glue for emergency repairs. The glue should be stored as per the glue manufacturer's instructions. (The average shelf life of glue is 6 months.)

5.4 PLATE MOUNTING

Refer to the General Assembly Drawing provided upon request for the proper sequencing of the plates. The diagonal line in Figure 17 (if painted

prior to disassembly) must reappear at the side of the plate pack as the plates are hanged on the frame.

5.5 HANGING PLATES ON THE FRAME

Proper handling during hanging of the plates on the frame is very important to protect the integrity of the plates. Proceed with the following steps, referring to Figure 20:

- Put plate in position 1 as shown in Figure 20 and hook it onto upper guide bar.
- Hold up the bottom of the plate so that it will clear the lower guide bar, and rotate the plate around the upper guide bar into position 2.
- Lower the bottom of the plate over the lower guide bar, to a vertical position 3.
- Slide plate toward the stationary head, against plates already installed.

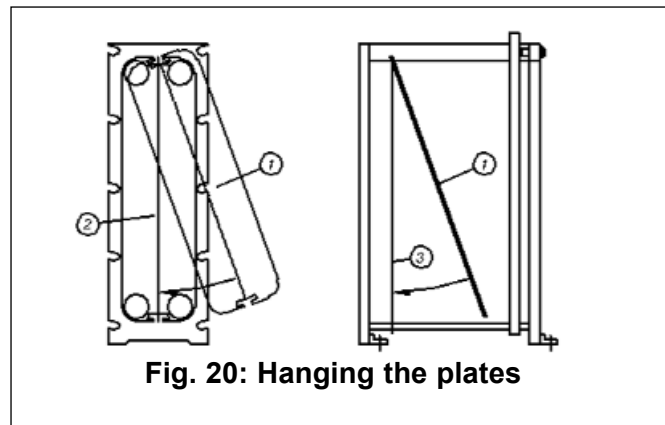
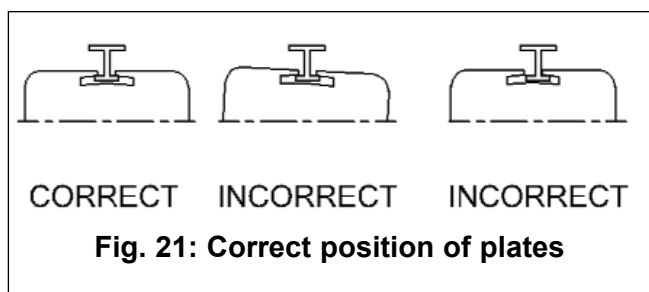


Fig. 20: Hanging the plates

The plates must be correctly positioned on the guide bars in order to achieve proper alignment of the plate pack (See Figure 21).

NOTICE

If before or during tightening the plate-pack appears misaligned at the sides or in the port holes, re-check and correct the positioning of each plate.



5.6 HYDROSTATIC TESTING

After each disassembly and reassembly, it is necessary to perform a hydrostatic test to the pressures indicated on the nameplate.

New units are hydrostatically tested separately on each circuit to the pressures indicated on the nameplate. (i.e., 1 circuit under pressure and the other open to the atmosphere).

Hydrostatic tests are performed to detect gasket leaks. Leaks from gaskets would appear either at the side of a plate pack or at drainage points (near nozzle). Gasket leaks always drain to the outside. It is not possible for one fluid to enter the opposite

circuit due to gasket failure. To simplify repairs, the location of a leak should be marked prior to disassembly of the plate pack.

Hydrostatic testing of one circuit (i.e. A) enables detection of defective plates. A hole in a plate would allow leakage between circuits. This is visible by water draining into the open circuit (B). When the plate pack is opened, the defective plate would be 1 of the 2, which are wet on circuit B, which was open to the atmosphere.

CAUTION

All tie rods must be in place and properly tightened before a hydrostatic test is made. Personal injury or substantial property damage can result.

CLEANING

NOTICE

The need to clean the heat exchanger and the method to be employed will depend on the type of fouling associated with each particular application.

Accumulation of deposits inside the plate pack will reduce the heat transfer rate and may cause excessive pressure drops through the system. Therefore it is extremely important to establish:

- a) the appropriate cleaning frequency
- b) the method of cleaning
- c) the suitable cleaning chemical solution (if required) to dissolve the hard deposits but not damage the plates or gaskets.

6.1 HOW TO MINIMIZE FOULING

6.1.1 PERIODIC FLOW-RATE INCREASES

One of the factors that determine the rate of fouling of the plates is the velocity of the fluids through the plate pack. It is recommended, especially for low fluid velocities, to increase the velocity at regular intervals, if possible. This will slow down the fouling process since the increased turbulence will remove some of the loose scale deposits from the heat transfer surfaces.

NOTICE

Typical intervals and duration of this preventive cleaning practice is four to six hours, every two to three weeks.

6.1.2 FILTRATION

The plate heat exchanger should not be used as a filter for process fluids. The exchanger plate design is specifically suited to clean fluids, and can become clogged by fibers or particulate matter. Filtration is advisable when solids are present in the fluids. Two options are available, the use of external filters connected in series with the plate exchanger and/or integral filters fitted within the ports of plate exchanger.

6.2 CLEANING WITHOUT OPENING EXCHANGER

6.2.1 BACK-FLUSHING METHOD

This method is recommended for fluids containing coarse particles such as fibres and debris that might accumulate in the port areas and distribution zones on the plates.

By briefly reversing the flow direction of the fluid these particles can be removed and carried away from the exchanger. The system piping should be configured in a manner to allow back flushing and drainage of the heat exchanger.

CAUTION

Ensure that the cleaning fluid use in the cleaning of the exchanger is compatible with the plate and gasket materials. Reference the cleaning fluid manufacturer's instructions for recommended uses and material avoidances.

6.2.2 CLEANING-IN-PLACE (CIP) METHOD

This method is recommended for high fouling processes where frequent cleaning is required. It is especially recommended where highly corrosive fluids are handled.

CIP PROCEDURE:

1. Drain both sides of the exchanger and flush the process circuit with cold water. If the cooling media contains common salt solutions, make sure that both circuits are well flushed with cold water before any cleaning operation.
2. Flush both sides of the exchanger with warm water 100-120 °F, (38-49 °C), until the effluent water is clear and free of process fluids.
3. Optionally, the plate pack tightening may be relaxed to about 3/16" (5 mm) per each 100 plates. This will relieve and allow the cleaning of the gaskets as dripping will occur. Make sure to record the actual distance "A" between heads prior to any loosening of the plate pack.

4. The choice of cleaning solution, the temperature and duration of cleaning procedure will depend on the type of deposits to be removed and must be compatible with the plate and gasket materials. Confirmation of material compatibility should be obtained from the cleaning fluid supplier.
5. When mixing the cleaning solution, use chloride free, or low chloride water, with a low hardness value. Concentrated cleaning solution must be added to the water before circulation begins.
6. It is recommended to pump the cleaning solution at flow-rates of up to 1.5 times the normal working flow-rate, where possible, without exceeding reasonable nozzle velocity (e.g. Carbon Steel nozzles: 15 ft/sec, or lined nozzles: 25 ft/sec). If possible, the cleaning solution should be pumped in the opposite direction to the normal flow. This will provide the advantages of back-flushing.
7. For units with high working flow-rates it might be difficult to attain high CIP flow-rates. In such cases, a solution capable of dissolving the deposits at lower circulating flow-rates should be used and/or the duration of the CIP process must be appropriately extended.
8. Centrifugal pumps should be used for circulating the cleaning solution. The flow-rate and operating pressure of the cleaning solution must be reached gradually to avoid pressure shocks that might result in gasket or plate damage.

CAUTION

Ensure that the cleaning fluid used in the cleaning of the exchanger is compatible with the plate and gasket materials. Reference the cleaning fluid manufacturer's instructions for recommended uses and material avoidances.

DANGER

When mixing acid and water, always add acid to water. Do not use hydrochloric acid for cleaning stainless steel plates. Caustic soda and concentrated nitric acid can cause serious injuries to skin and mucous membrane. The contractor should use care when handling these substances. Protective goggles, gloves and outerwear are highly recommended.

CAUTION

The edges of the exchanger plates contain sharp edges. Use care and wear safety gloves when handling the plates.

9. After the cleaning solution has been circulated, the exchanger and the adjacent piping must be flushed with clean water.
10. If the plate pack tightening has been relaxed, re-tighten to the recorded dimension 'A' before bringing the exchanger back on line.

CIP FOR REMOVAL OF LIME SCALE AND OTHER SIMILAR DEPOSITS.

One common type of fouling is the precipitation of calcium compound from cooling water and other sources.

- a) Proceed as per the applicable CIP instructions, circulating a solution of 2 to 3% phosphoric acid solution at 70°F (20°C) for two hours.
- b) Flush with cold water until the cleaning solution has been completely removed from the plate pack.

6.3 CLEANING OPEN HEAT EXCHANGER

Although CIP is a very efficient way of maintaining the heat exchanger in good operating order, it is sometimes necessary to dismantle the unit for cleaning.

CLEANING

For manual cleaning of the plates, proceed as follows:

1. Open the exchanger as outlined in section 5.1 of this manual.
2. Slide plates apart to allow cleaning by brush or water rinsing.
3. For cleaning with high-pressure water jet, it is recommended to lay the plates flat on a firm surface to avoid damage. To avoid dislodging of gaskets, always direct the water jet at right angles to the gasket face.
4. NEVER use a steel brush or steel wool on the plates. If required, a fibre brush should be used.
5. Be careful not to scratch the gasket surfaces.
6. After brushing rinse well with water and wipe dry.
7. After completion of manual cleaning and careful inspection of all components, proceed to assemble the unit as per Section 5.2 of this manual.

TO REMOVE HARD DEPOSITS SUCH AS CALCIUM COMPOUNDS, OXIDE OR CARBONATE DEPOSITS:

- a) Prepare a solution of 10% nitric acid:
 - 1 part volume: 65 % HNO₃ (specific weight 1.4)
 - 9 parts volume: water
- b) Apply the cleaning solution to the plates and let stand for 10 minutes. Brush and rinse with water. If necessary, repeat this operation several times.
- c) Neutralize with a diluted caustic solution followed by a thorough rinse with water.

CAUTION

Ensure that the cleaning fluid use in the cleaning of the exchanger is compatible with the plate and gasket materials. Reference the cleaning fluid manufacturer's instructions for recommended uses and material avoidances

This section will assist users in trouble shooting problems that arise with the heat exchanger. These guidelines are meant to serve as a guide only. If further assistance is required please contact Triangle Tube Engineering Department.

Symptom 1

External leakage between plate pack and fixed head or mobile head

Possible Causes:

- Gasket failure (most common cause)

Finding The Problem:

- Mark the point where the leak occurs.
- Open the exchange plate pack
- Examine the condition of the gasket and plate alignment

Corrective Action:

- Defective gaskets: Defective gaskets must be replaced.

Notes:

- When a significant number of gaskets need replacement, it is recommended that a complete new gasket set be installed. This will result in easy sealing and will ensure longest operating life.

Possible Causes :

- Nozzle liner failure (rare)

Finding The Problem:

- If the gasket appears to be in good condition, check nozzle liner for any visible cracks or perform a dye penetration test to locate failure.

Corrective Action:

- Tig weld the crack in the liner if accessible. If not accessible, the liner must be replaced.

Symptom 2

External leakage between nozzle and fixed or mobile head

Possible Causes:

- Nozzle liner failure

Finding The Problem:

- Check nozzle bolting tension, piping alignment, etc. to make sure piping loads are not causing the leak.
- If the leak persists, disconnect flange, examine nozzle gasket and replace if necessary.
- If the nozzle gasket is found in good condition, open exchanger and check nozzle liner for any visible cracks or perform a dye-penetration test to locate failure.

Corrective Action:

- Tig weld the crack in the liner if accessible. If not accessible, the liner must be replaced.

Symptom 3

External leakage between plates

Possible Causes:

- Extremely high pressure and/or temperature
- Incorrect tightening dimension
- Gasket failure

Finding The Problem:

- Check the operating pressure.
- Check tightening dimension and alignment of heads.
- If pressure is within limits and tightening dimension is correct, leak is due to gasket failure.

Corrective Action:

- Restore pressure and temperature to within acceptable levels.
-

TROUBLE SHOOTING

- Re-tighten plate pack, see Section 5.2 of this manual.
- Open the plate pack, see Section 5.1 of the manual and replace the damaged gaskets.
- Alternatively, remove the plates containing the damaged gasket.
- Close the plate pack. Make sure to obtain the new tightening dimension if any plates have been removed.

Symptom 4

Internal leakage (Cross Leak)

Possible Causes:

- Hole in plate

Finding The Problem:

- Shut the exchanger down (See Section 4.4) of the manual and drain both sides.
- Disconnect the nozzles of one circuit and apply a slight water pressure to the other circuit.
- By looking into the open circuit, it is possible to locate the approximate location of the leak.
- Open the exchanger plate pack
- Pinpoint the leaking plate(s) by:
 1. Visual inspection of gaskets and plates close to the leak. Look for cracks, pin holes, discoloration of the plate, etc.
 2. Holding the plate against the light might reveal cracks or pin holes in the plate.
 3. Dye penetration test: Spray the back side of the plate with the dye-penetration liquid and the other side with the developer. Cracks will be visible after 5-10 minutes.

Corrective Action:

- Replace any defective plates.

Notes:

- When a significant number of gaskets need replacement, it is recommended that a complete new gasket set be installed. This will result in easy sealing and will ensure longest operating life.
- If the failure is due to corrosion, inspect all plates since corrosion will occur normally along the entire plate pack.

Symptom 5:

Extremely low thermal performance and very high pressure drop

Possible Causes:

- Channel throat blocked with debris
- Blocked channels
- Plates installed incorrectly

Finding The Problem:

These conditions typically cause high pressure drops or low flow rates.

- Accurately measure the inlet and pressures as close as possible to the exchanger.
- Compare recorded values to the design values.

Corrective Action:

- If accumulation of debris inside the port and throat areas is suspected, back-flushing at high flow-rate is recommended.
 - If back-flushing is not possible or does not solve the problem, the blocking particles might be lodged in the channels. Open the unit and remove debris.
-

Symptom 6**Impaired performance associated with heat transfer decline***Possible Causes:*

- Fouling
- Actual physical properties of fluids different from those of design
- Lower flow-rates
- Presence of non-condensable gases
- Steam condensate flooding the channels.

Finding The Problem:

- Accurately measure the inlet and outlet temperatures and pressures as close as possible to the exchanger.
- Accurately measure the flow-rates.
- Compare recorded values to the design values.
- Confirm the physical properties of the fluids.

Corrective Action:

- If the heat transfer decline is due to fouling, clean the heat exchanger according to an appropriate method.
 - If low performance is due to different physical properties or low operating flow rates, contact Triangle Tube Engineering Department for advice.
 - If the problem is caused by flooding of the plates, the steam traps/vacuum pump may need to be repaired or resized and replaced.
-

SPARE PARTS & SERVICE INQUIRY / ORDER FORM

PO #:

SHIPPING ADDRESS:

INVOICING ADDRESS:

Company Name: _____

Company Name: _____

Address: _____

Address: _____

City, State: _____

City, State: _____

Zip Code: _____

Zip Code: _____

Phone Number: _____

Phone Number: _____

Purchasing Contact: _____

Purchasing Contact: _____

HEAT EXCHANGER Model: _____ SERIAL #: _____ WO#: _____

If the heat exchanger has been modified since installation, please provide detailed information:

New panel gaskets:

Request for service / comments / problems:

SEND COMPLETED FORM TO:

Triangle Tube
1 Triangle Lane
Blackwood, NJ 08012
(856) 228 8881 Phone
(856) 228 35 84 Fax

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