



# Gasketed Plate Heat Exchangers

Operation, Maintenance  
& Installation Manual



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# GASKET PLATE HEAT EXCHANGERS

UNIT TAG NO.: _____	ORDER NO. _____
ENGINEER: _____	SUBMITTED BY _____ DATE _____
FLO FAB REPRESENTATIVE: _____	APPROVED BY _____ DATE _____

**CONNECTION DESCRIPTIONS**

- \*ALWAYS DESCRIBE PORT LOCATIONS AS VIEWED FROM THE FIXED END.
- \*STARTING IN UPPER LEFT-HAND CORNER, NUMBER THE PORTS 1 THRU 4 IN A CLOCKWISE MANNER.
- \*PORTS ON THE FIXED END USE AN "F" SUFFIX.
- \*PORTS ON THE MOVABLE END USE AND "R" SUFFIX.

**PORT NUMBERING:**  
**LOOKING AT FIXED END, CLOCKWISE 1-4.**

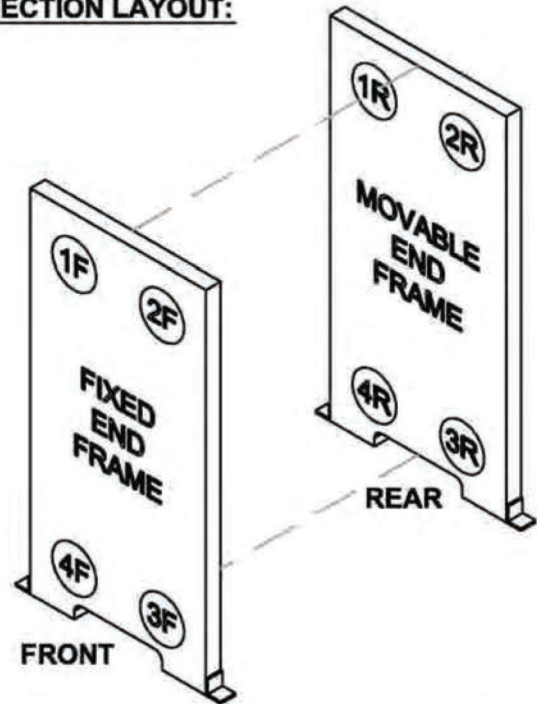
**FRONT**

- 1F - TOP LEFT, FIXED END FRAME
- 2F - TOP RIGHT, FIXED END FRAME
- 3F - BOTTOM RIGHT, FIXED END FRAME
- 4F - BOTTOM LEFT, FIXED END FRAME

**REAR**

- 1R - TOP LEFT, MOVABLE END FRAME
- 2R - TOP RIGHT, MOVABLE END FRAME
- 3R - BOTTOM RIGHT, MOVABLE END FRAME
- 4R - BOTTOM LEFT, MOVABLE END FRAME

**CONNECTION LAYOUT:**



**PASS UNIT CONNECTION LOCATION:**

<input type="checkbox"/> ONE PASS	<input type="checkbox"/> TWO PASS	<input type="checkbox"/> THREE PASS	<input type="checkbox"/> FOUR PASS
HOT IN → 1F	HOT IN → 4F	HOT IN → 4F	HOT IN → 4F
HOT OUT → 4F	HOT OUT → 4R	HOT OUT → 1R	HOT OUT → 4R
COLD IN → 3F	COLD IN → 3R	COLD IN → 2R	COLD IN → 3R
COLD OUT → 2F	COLD OUT → 3F	COLD OUT → 3F	COLD OUT → 3F

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## 1.1 INTRODUCTION

This manual is intended as your general guide for the proper installation, operation and maintenance of your FLO FAB\* Gasketed Plate Heat Exchangers. We advise you to study it thoroughly and follow the Instructions.

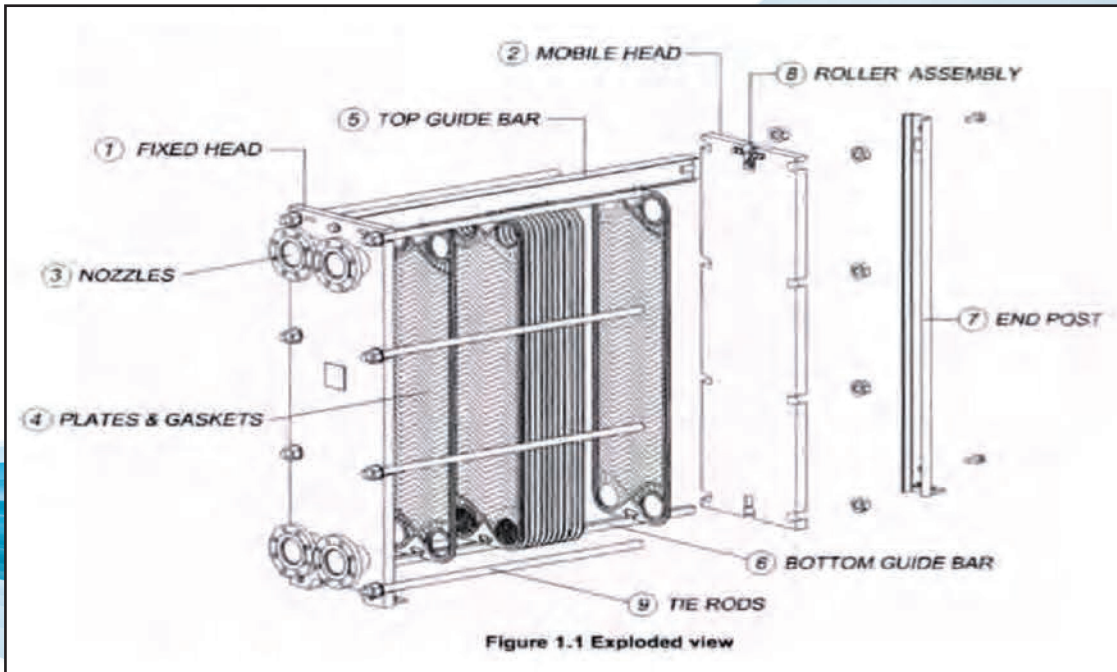
FLO FAB\* accepts no responsibility or liability for damage caused by incorrect installation, operation or maintenance due to failure to observe these instructions.

## 1.2 DESCRIPTION

A FLO FAB\* Heat Exchanger consists of a plate pack of thin metal plates specially 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.

## 1.3 FRAME

### 1.3.1 TYPICAL FRAME COMPONENTS



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

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

#### (3) Nozzles

There are three types nozzles:  
**NPT Nipples:** for Model FF84, FF270 and smaller, size from 1" to 2 1/2".  
**Studded ports:** for Model FF800, FF1625, FF2900, FF5325 and larger, size to fit 4" ANSI flanges and up, rated from 150# to 300 #.  
**ANSI flanges:** available for all models. Size from 1" ANSI and up, 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 1.3.3 for nozzle terminology.

#### (4) Plates and Gaskets

See section 1.4 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 FF1625, FF2900, FF5325 for full support. Keeps the exchanger in rigid position.

#### (8) Roller

Installed I beam of Model FF1625, FF2900, FF5325 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**.

### 1.3.2 FRAME SERIES

FLO FAB\* frame types are titled with two or three letters. The first letter Indicates the type of foot-print, 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 studed port nozzles  
N:Threaded nipple nozzles  
F:With flanged nozzles

The following frame series are available:



FF270 &  
Smaller

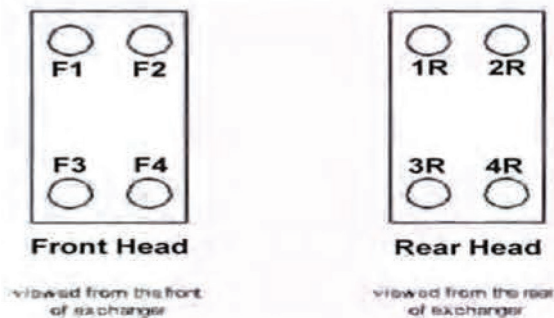
FF800

FF1625 &  
Larger

**Figure 1.2 Available Frame Series**

### 1.3.3 NOZZLES TERMINOLOGY

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



**Figure 1.3 Nozzles Terminology**

### 1.4 PLATES & GASKETS

#### 1.4.1 THE PLATE PACK

The General Assembly Drawing, supplied with each FLO FAB Heat Exchanger 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.

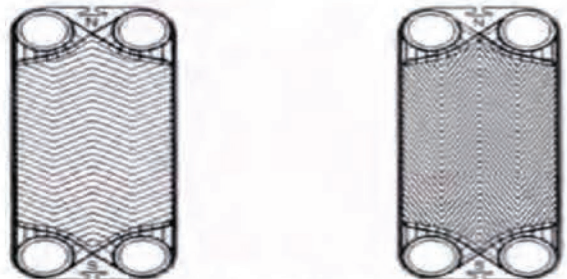
The plates are referred to as EVEN PLATE or ODD PLATE depending on the orientation of their gasket with respect to the N and S ends, and the ports that it blocks off.

ODD and EVEN plates control the orientation of flow of the fluids in the exchanger (See figures 1.7 and 1.8 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.

#### 1.4.2 Plate Corrugation Patterns



**Figure 1.4 Plate Corrugation Patterns**

All plates are identified with three letter code The first two letters Identify High Theta, Medium Theta and Low Theta. The last letter identifies plate gap - process gap (P), narrow gap (N), and mixed gap (X).



**Figure 1.5 Types of Gaskets**

NOTES: 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

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 1.6 Below)

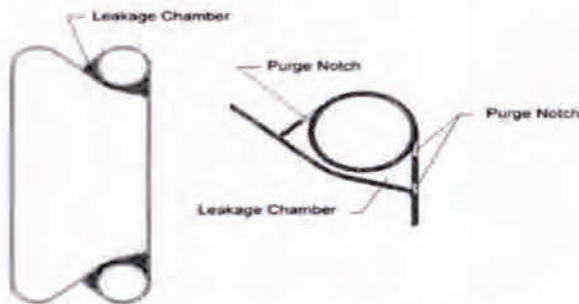


Figure 1.6 Comer Gasket Leakage Chamber

**1.4.4 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

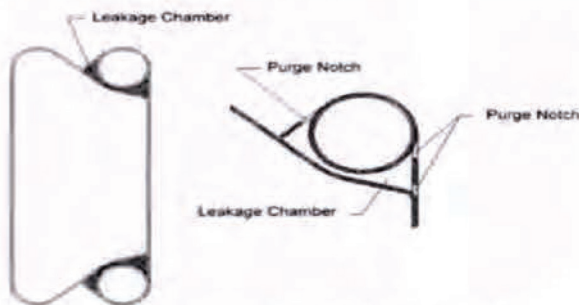


Figure 1.7 - Models Same-Side Flow

Model-Diagonal Flow ODD and EVEN plates are different from each other and are not interchangeable without replacing the gaskets (See figure 1.8 below.)

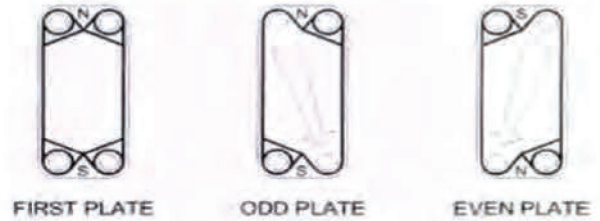


Figure 1.8 Models with Diagonal Flow Flo Fab Standard Design

**1.4.5 SPECIAL PLATES**

A standard plate is a plate with four port openings. Plates with any or all ports blanked off are called Special Plates and are designated as such in the heat exchanger drawing.

Plates are named according to the position of their «filled» ports (See Figure 1.9 below.)

Examples:

- 4F                    4 Filled ports
- 2FN                2 Filled North
- FNW              1 Filled North-West
- 2FN FSW        2 Filled North & 1 Filled South-West

NOTE: Special Plates are typically ODD plates.

Here are the names of the various Special Plates:

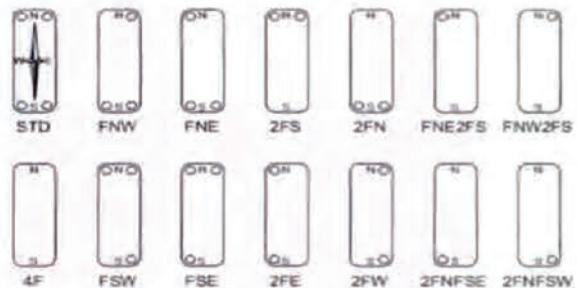


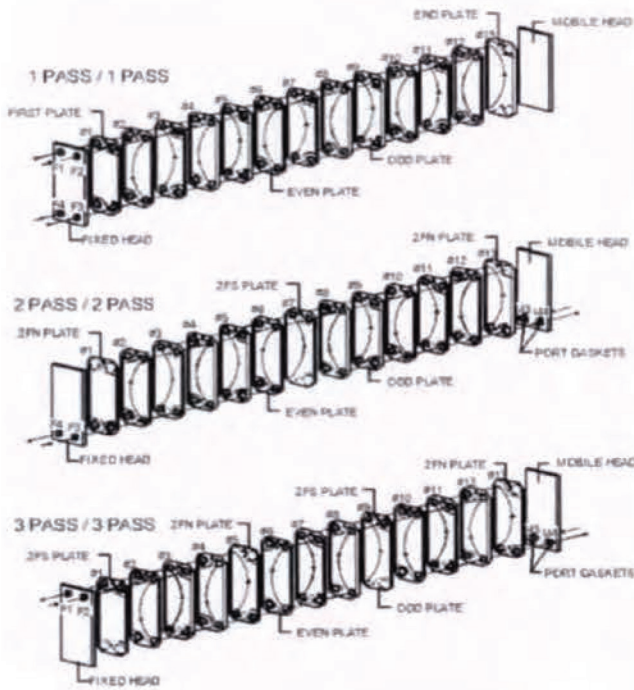
Figure 1.9 Special Plates



**1.4.6 REINFORCED PLATES**

Plates with reinforced port areas are provided for units with higher operating/design pressures This reinforcement consists of a corrugated strip of the same material as the plate which is welded into.

**1.4.7 TYPICAL PASS ARRANGEMENTS FOR STANDARD MODELS**  
**FLO FAB Standard Models**



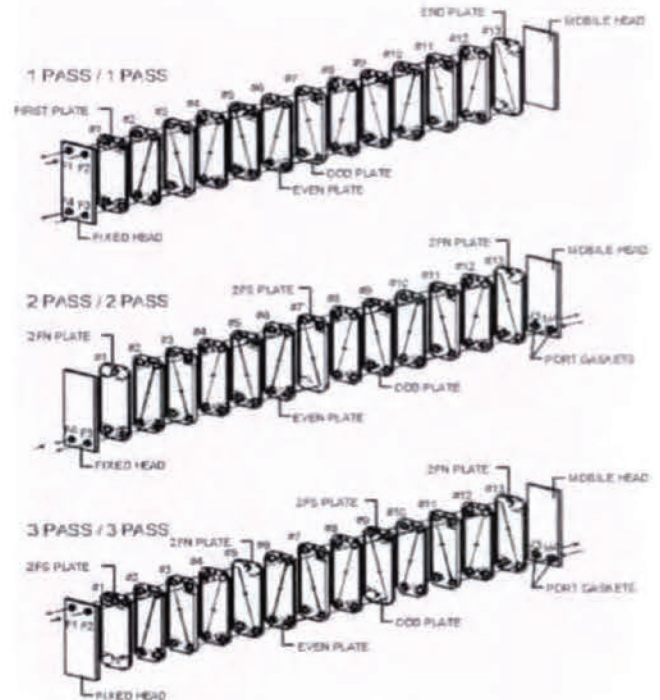
(Same side flow)

**Figure 1.10 Typical Pass Arrangements for all Standard Models**

the gasket groove, around the section of the port that is not supported by the gasket

**1.4.8 TYPICAL PASS ARRANGEMENTS FOR SPECIAL MODELS**

**FLO FAB Special models**  
**FF800 & Larger**



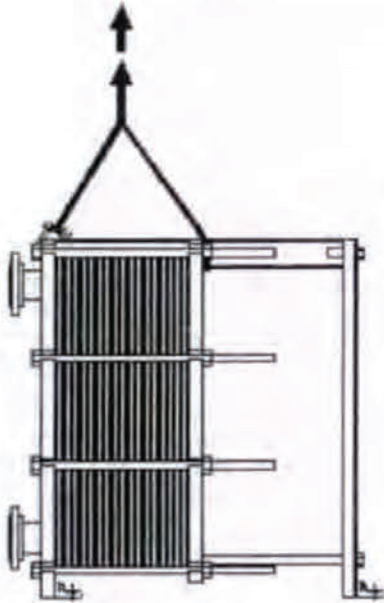
(Diagonal Flow)

**Figure 1.11 Typical Pass Arrangements for special models {Model FF800 and Larger}**



FLO FAB Heat Exchangers are delivered pre-assembled and tested. They should be rigidly fixed on the floor by means of anchor bolts.

## 2.1 LIFTING THE PLATE HEAT EXCHANGERS



**Figure 2.1 Lifting the Plate Heat Exchanger**

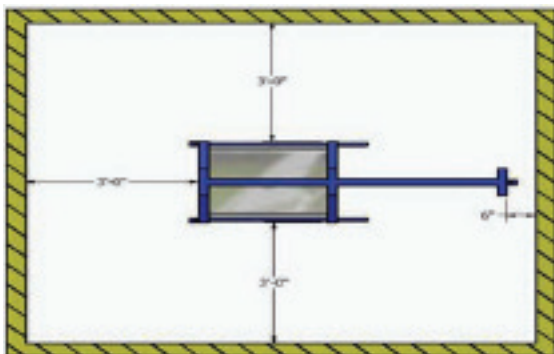
## 2.2 DRIP TRAY

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

## 2.3 INSTALLATION AND PIPING

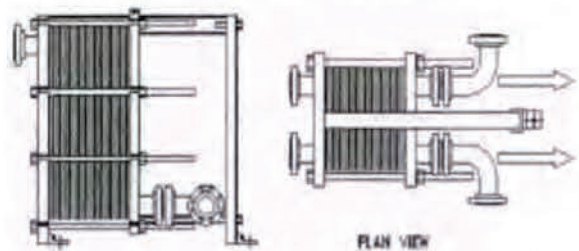
The following steps are recommended for the correct Installation of the heat exchanger:

- locate the exchanger in an area not congested by piping or other equipment.
- Provide approximately 3 feet (1 meter) of free space around the exchanger for easy maintenance.



**Figure 2.2 - Clearance for FLO FAB Installation**

- Ensure that the exchanger is level when installed
- Ensure 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
- Nozzles located at the mobile head must be installed with spool pieces as shown in figure 2.3. to allow the head to move fully backward.



**Figure 2.3 Mobile Head Fitted with Spool Nozzles**

- Shut-off valves are recommended for nozzles so that FLO FAB can be shut down and opened without disturbing adjacent systems. Quick action valves should be avoided to prevent water hammer.

## CAUTION

Models FF270 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 do so will cause damage to the gasket between the nozzle inner face and the adjacent plate.

- Pumps sending fluids to the heat exchanger should be equipped with throttling valves. Were the maximum pump discharge pressure might exceed the maximum working pressure of the exchanger, a safety relief valve should be provided. Pressure control valves (when installed) should be located at the inlets to the exchanger. Positive displacement pumps (especially)

## 2.4 STORING FLO FAB

If it is necessary to store FLO FAB\* for a long period of time before commissioning 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 FLO FAS 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

## 2.5 ALLOWABLE NOZZLE LOADS

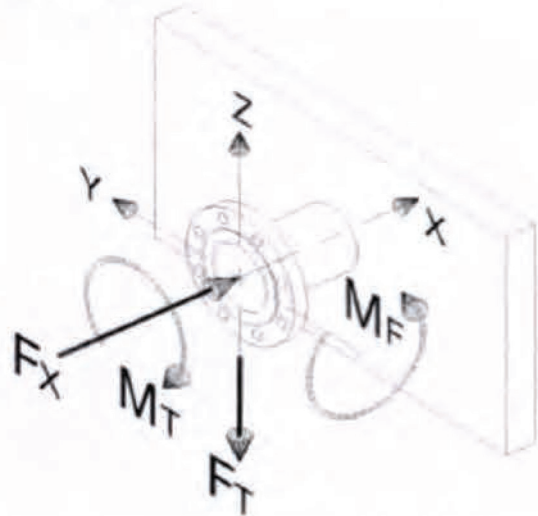
Care must be taken not to damage the nozzles of a heat exchanger. Damage can occur in a number of common ways that excessively push, pull or twist the nozzles. For example:

- If piping has insufficient play in it (or too much play) it can pull on or push against the nozzle, or
- 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, so always use lifting holes and the procedure given in 2.1.

### CAUTION

Make sure that the piping system connected to the exchanger is secured to protect FLO FAB-against sudden pressure surges and temperature fluctuation.

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



**Figure 2.4 Nozzle Loads & References Axes**

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	2½"	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	7500

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

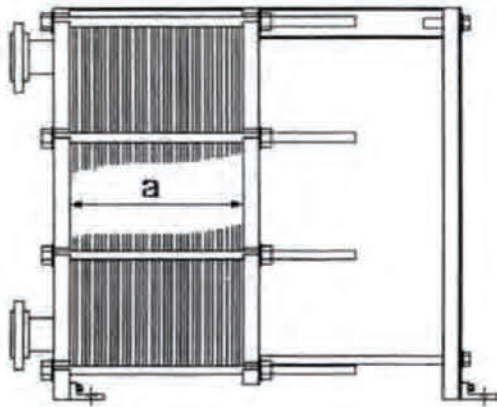
Fx = resultant direct force on nozzle  
Ft = resultant radial force on nozzle

Mt = resultant torsion moment on nozzle  
Mf = resultant bending moment on nozzle

TABLE 1 - Maximum Allowable Nozzle Loads

## 2.1 INITIAL OPERATION

a) Make sure that the tightening dimension 'a' (distance between the inner faces of the fixed and mobile heads) 15 within the limits specified in the General Assembly Drawing, otherwise see section 4 2.1 or 4.2.2 of this manual for tightening instructions.



b) Before start-up, especially after a long period of stoppage. Ensure that the piping system connected to FLO FAB is free of scaling or any other foreign matter that will clog the plate pack. The exchanger will act as a filter for solid particles of any considerable size.

c) Make sure that all nozzles are property fastened.

d) Ensure that your system set up is within the heat exchanger's design limits for temperature and pressure as allowed by the nameplate.

## 3.3 START-UP

To start up the heat exchanger, follow steps 'a' to 'f'. Begin with the circuit with the least severe operating

- a) Close the feed valve between the pump and FLOFAB
- b) Fully open the shut-off valve at the outlet (if one was Installed).
- c) Open the vent valve.
- d) Start the pump.
- e) Slowly open the feed valve
- f) Close the vent valve when all air has been removed.
- i) The steam must be turned on last and off first. Do not leave the steam on with the liquid side turned off.
- ii) Sudden opening and closing of the valves may deform plates to the point of being non serviceable. Valves must be set to open gradually.
- iii) Start-up and shut down must be controlled to protect the exchanger from shocks. The amount of heating or cooling should be controlled using throttling valves in conjunction with the process thermometers.

## 3.3 SHUT DOWN

### 3.3.1 BRIEF STOPPAGE

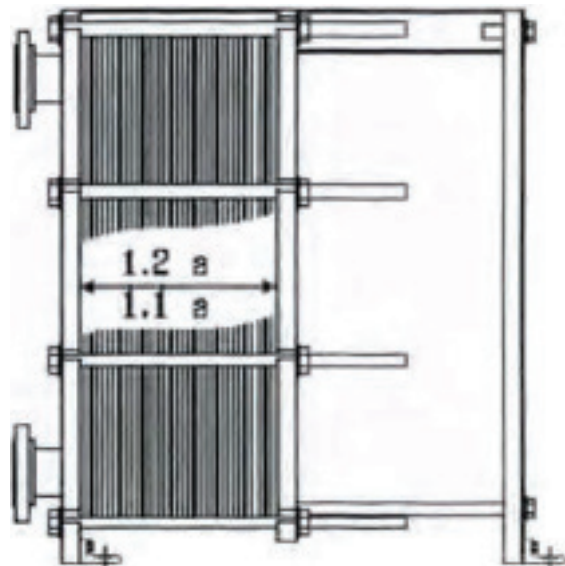
If FLO FAB is to be shutdown for a short period of time, such as for Inspection, service or pump stoppage, proceed as follows

1. Slowly dose the feed valves, starting with the most severe circuit
2. Switch off the pumps
3. Close the valves at the outlet nozzles

### 3.3.2 PROLONGED STOPPAGES

For long term stoppages of one month or longer, proceed as above and follow the additional recommendations below;

4. Vent and drain FLO FAB
5. Flush the plate pack and perform the appropriate cleaning procedure. Beware of any residual chlorine, either from the process fluids or the rinse water, since this can cause pitting of the plates.
6. Slacken the plate pack by 10 to 20% of the existing dimension 'a' (a+ 10 to 20%)
7. Refer to section 2.4 of this manual, Storing FLO FAB



**Figure 3.2 Slackening the Plate Pack for Storage**

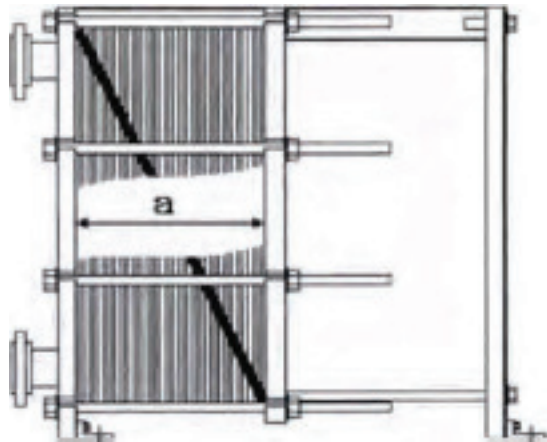
## CAUTION

When re-starting FLO FAB, make sure to re-tighten the plate pack to the 'a'-dimension and proceed as per INITIAL OPERATION, and START-UP

## 4.1 OPENING FLO PLATE

Prior to opening FLO PLATE, proceed as follows

- a) Shut-down as per instructions In 3.3
- b) Disconnect any nozzles on the mobile head
- c) Clean the exposed section of the upper guide bar, to allow easy movement of the plates
- d) Clean the mobile head roller so that It can move easily
- e) Clean and lubricate the tightening rod threads
- f) Record the current tightening dimension 'a'
- g) Paint a diagonal line across the side of the plate pack to facilitate the correct sequencing



**Figure 4.1 Paint a diagonal line across the Plate Pack**

### 4.1.1 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 114" to 112", and no more. It's important that the heads remain parallel to avoid damaging (crushing) the plates between them.
2. When all he rods have been fully loosened, they may be removed. Push the Rear 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.

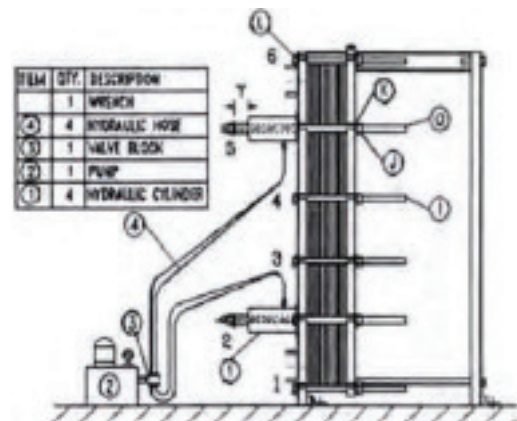
## CAUTION

The plates have sharp edges.  
Wear safety gloves when handling plates.

### 4.1.2 HYDRAULIC OPENING

1. With a wrench, loosen the hexagonal nuts (Item J, Figure 4.2) from the two pairs of tie rods (Item O) In positions 2 & 5 (also shown In Figure 4.2)
2. Loosenthefournuts(ItemJ)toalengthcorrespondingtotheopenedlengthofthehydrauliccylinder
3. Push the four tie rods (Item O) 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.

**DO NOT USE A SCREW DRIVER OR ANY METAL**

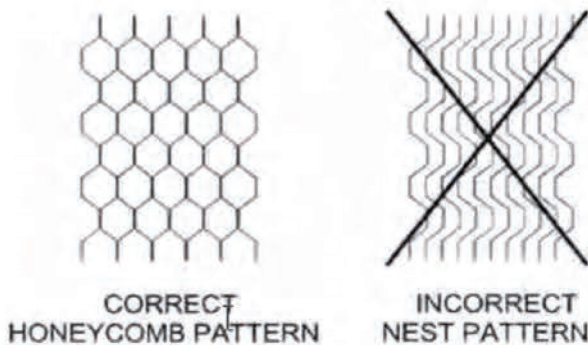


**Figure 4.2 Hydraulic Opening of FLO PLATE**

**4.2 CLOSING FLO PLATES®**

Prior to closing FLO PLATES

- a) Make sure that the plates and gaskets are free of foreign matter or contaminants. If necessary, clean with a soft cloth or brush.
- b) Clean the guide bars to ensure easy movement of the plates when installing and tightening.
- c) Install all plates in the correct sequence in accordance with the general assembly drawing. The diagonal line painted on the plate pack side must reappear unbroken, and the honey-comb pattern made by the plate edges should be uniform as shown in Figure 4.3, below.



**Figure 4.3 Pattern of Sides of Plate Pack**

NOTE: 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.

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

**CAUTION**

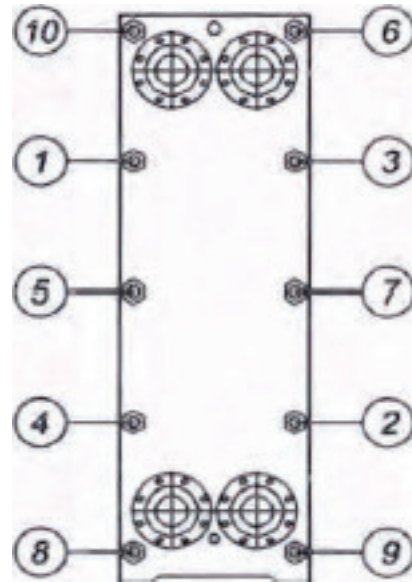
Never tighten FLO FAB PLATE while it is under pressure.

**CAUTION**

When re-starting FLO FAB, make sure to re-tighten the plate pack to the 'a'-dimension and proceed as per INITIAL OPERATION, and START-UP

**4.2.1 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.
- 3. Tighten the plate pack using diagonally opposite tie rod pairs, in a sequence similar to that given in Figure 4.4 below. Ensure during closing that the fixed and mobile heads are kept parallel to each other to within 1/16" to 1/32".
- 4. Install and tighten the remaining tie rods and ensure that all tie rods are under tension.



**Figure 4.4 Example of Manual Tightening Sequence**

- 5. If old gaskets are still used, the tightening dimension should be between the recorded dimension 'a' 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 between the minimum and maximum values specified on the General.
- 6. After final tightening, the fixed and mobile heads must be parallel to within 1/16" in all directions, to ensure proper plate pack alignment.
- 7. The unit is now ready for hydro test.

## 4.2.2 HYDRAULIC CLOSING

1. Push the mobile head into contact with the plate pack.
2. Install the four tie rods (Item O. Figure 42) 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 4.2)
5. Activate the hydraulic pump and allow the cylinders to tighten the plate pack
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. The sides of the plate pack must form an uninterrupted honeycomb pattern as shown in Figure
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 'a' 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
10. Finish tightening the be 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 hydro test.



## 4.3 RE-GASKETING

FLO FAB gasketed plate heat exchangers, depending on model and materials of construction, are available with glued or glue less gasketing systems. Please consult the general assembly drawing of your unit to verify the gasketing system used.

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.

### 4.3.1 GASKET GLUING

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

#### a) 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 dean. 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

#### b) GLUING THE GASKETS

We recommend for cold glulng, the use of 3M's 3MEC1099 adhesive or its .equivalent (glue can be 1 or 2 parts)

## CAUTION

Care must be taken not to scratch the gasket groove or leaks may develop underneath the gasket

#### NOTE:

For best results, carefully follow the manufacturer's Instructions for the glue that you select.

Prior to gluing, review section 1.4.3 of this manual for a good understanding of the FLO FAB gasket terminology, e.g. 4 corner gasket (4 Cr), is the standard gasket in odd or even position.

Perform a visual inspection and make sure 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.

**NOTE:**

- a) Do not roughen fiber gaskets.
- b) 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. 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 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 manufacturer's instructions

**CAUTION**

Glue must be compatible with both the plate material and the gasket material. If in doubt consult the glue

**4.3.2 GLUE LESS GASKET REPLACEMENT**

FLO FAB glue less gasket systems allow gasket to be snapped in place in the «honeycomb» grooves on the plate perimeter.

Please contact your nearest FLO FAB office or representative for additional instructions, if required.

**4.3.3 STORING SPARE GASKETS AND GLUE**

It is recommended that spare gaskets be readily available for each heat exchanger. 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 material 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.)

**4.4 PLATE MOUNTING**

Refer to the General Assembly Drawing provided with your unit for the proper sequencing of the plates. The diagonal line in Figure 4.1 (if painted poor to disassembly) must reappear at the side of the plate pack as the plates are.

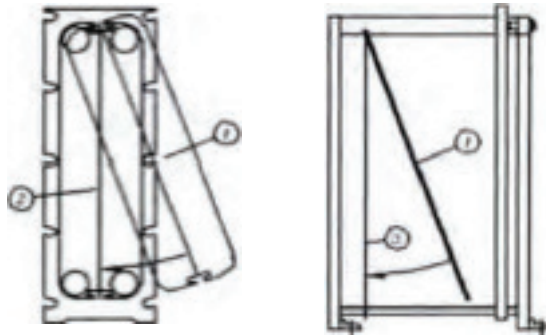
**4.5 HANGING THE PLATES ON THE FRAME**

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 4.5 below:

## 4.5 HANGING THE 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 4.5 below:

- a) Put plate in position 1 and hook it onto upper guide bar
- b) 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.
- c) Lower the bottom of the plate over the lower guide bar, to a vertical position 3.
- d) Slide plate toward the stationary head, against plates already installed.



**Figure 4.5 - 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 4.6 below)

**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.**



**Figure 4.6 Correct position of plates**



## 5.0 CLEANING

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. and
- c) the suitable cleaning chemical solution (if required) to dissolve the hard deposits but not damage the plates or gaskets

### 5.1 HOW TO MINIMIZE FOULING

#### 5.1.1 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.

**Typical intervals and duration of this preventive cleaning practice is four to six hours every two to**

#### 5.1.2 FILTRATION

FLO FAB's should not be used as a filter for process fluids. FLO FAB design is specifically suited to dean fluids, and can become dogged by 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 FLO FAB, and also integral filters fitted within the ports of FLO FAB

**For more Information on filters, consult your nearest FLO FAB office.**

## CAUTION

Ensure that the cleaning fluid is compatible witt, the plate an gasket materials. Your cleaning solution supplier should be contacted for recommendations.

**5.2 CLEANING WITHOUT OPENING FLO PLATE**

**5.2.1 BACK FLUSHING METHOD**

This method is recommended for fluids containing coarse particles such as fibers 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. A special piping configuration is required for this method. (Contact your nearest FLO FAB office for advice.)

**5.2.2 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. Clean 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 3116" (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

**CAUTION**

Never inject chemicals while CIP is in process

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 flowrate and operating pressure of the cleaning solution must be reached gradually to avoid pressure shocks that might result in gasket or plate damage.

**CAUTION**

When mixing acid and water, always add acid to water. Do not use hydrochloric acid for cleaning stainless steel plates. The edges of plates are sharp. Wear safety gloves when handling them. Caustic soda and concentrated nitric acid can cause serious injuries to skin and mucous membrane. When handling these substances always use protective goggles and rubber gloves.

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 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 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.



**5.3 CLEANING THE 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.

For manual cleaning of the plates proceed as follows:

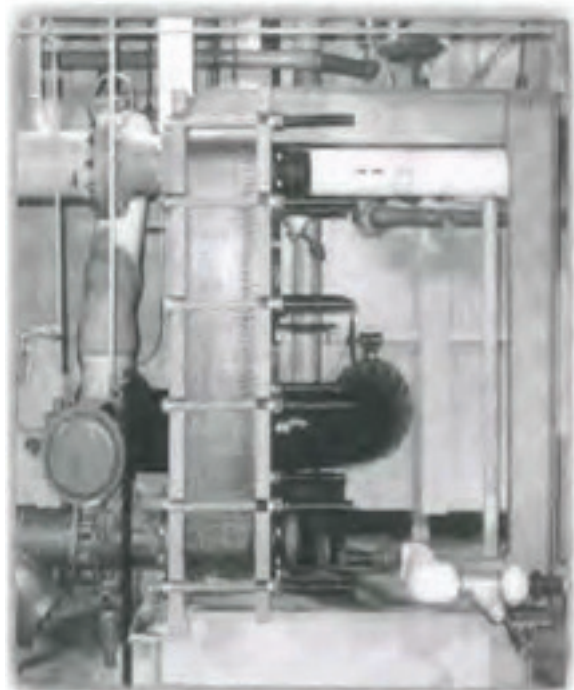
1. Open FLO PLATE as indicated in section 4.1 of this manual.
2. Slide plates apart to allow cleaning by brush or water rinsing.
3. For cleaning with high-pressure water Jet, It is recommended to lay the plates flat on a firm surface to avoid damage, to avoid dislodging of gaskets, always direct the water jet at right angles to the gasket face.
4. NEVER use a steel brush or steel wool on the plates. If required a fiber 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.

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

- a) Prepare a solution of 10% nitric acid:  
1 part volume: 5 % HNO<sub>3</sub> (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**

Closely follow the safely recommendations from the cleaning agent manufacturer



This section will assist users in trouble shooting problems that arise with the heat exchanger. This table is meant to serve as a guide only. If further assistance is required please contact FLO FAB

**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 FLO FAB (see page 8)  
Examine the condition of the gasket and plate alignment

**Corrective Action:**

Defective gaskets: Defective gaskets must be replaced.

**Remarks:**

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 (2):

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 penetrant test to locate failure.

**Corrective Action:**

Tig weld the crack in the liner if accessible. If not accessible, the liner must be replaced.  
Contact FLO FAB for advice.



**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 If found in good condition, open exchanger and check nozzle liner for any visible cracks or perform a dye-penetrant test to locate failure.

**Corrective Action:**

liner failure  
Tig weld the crack In the liner if accessible. If not accessible, the liner must be replaced.  
Contact FLO FAB for advice.

**Symptom 3:**

External leakage between plates

**Possible Causes:**

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

**Finding The Problem:**

Check the operating pressure.  
Check tightening dimension and altgnment of heads If pressure is wi1hin limits and tightening dimension is correct, leak is due to gasket failure

**Corrective Action:**

Restore pressure and temperature to within acceptable levels

Retighten plate pack, see page 10 of this manual.

Open the plate pack, see page 8 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



This section will assist users in trouble shooting problems that arise with the heat exchanger. This table is meant to serve as a guide only. If further assistance is required please contact FLO FAB

**Symptom 4:**

Internal leakage (Cross Leak)

**Possible Causes:**

Hole In plate

**Finding The Problem:**

- Shut the exchanger down (See page 7) of the manual and drain both sides.
- Remove 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 FLO PLATE (see page 8)
- 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 penetrant test: Spray the back side of the plate with the dye-penetrant liquid and the other side with the developer cracks will be visible after 5-10 minutes.

**Corrective Action:**

Replace any defective plates.

**Remarks:**

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. -
  - Check the honeycomb pattern on the plate-pack sides.

**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

lodged in the channels. Open the unit and remove debris.

- If the honeycomb pattern of the pack is not uniform, the plates are mounted the wrong way. Open the exchanger and re-assemble.

**Remarks:** If problem is not Identified, contact FLO FAB for assistance.

**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 FLO FAB 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.

**Remarks:**

If problem is not identified, contact FLO FAB for assistance.



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