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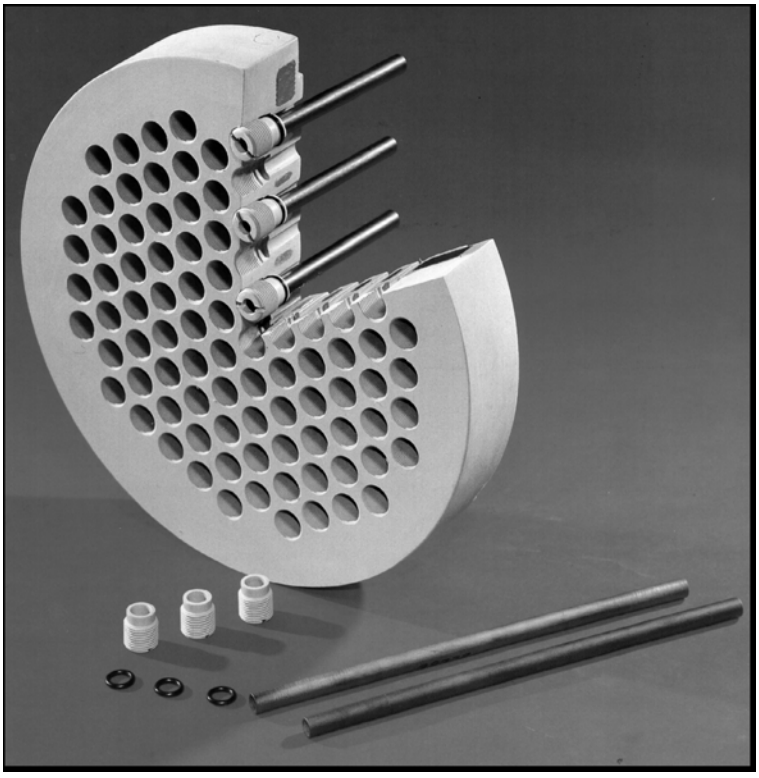
SILICON CARBIDE POLYTUBE® HEAT EXCHANGERS

INSTALLATION
COMMISSIONING
MAINTENANCE



REF: SICMAN.ED

SILICON CARBIDE POLYTUBE® HEAT EXCHANGER

WE STRONGLY RECOMMEND THAT YOU READ THIS MANUAL CAREFULLY AND FOLLOW THE INSTRUCTIONS TO ENSURE SAFE AND RELIABLE OPERATION OF THE UNIT.

Model #: _____

Carbone Drawing No.: _____

Customer/Ultimate owner: _____

& address : _____

_____

P.O. number: _____

Project No.: _____

Equipment tag number(s): _____

Vessel Serial number(s): _____

Diameter (shell) : _____

Height or length: _____

Weight empty: _____

Weight full of water: _____

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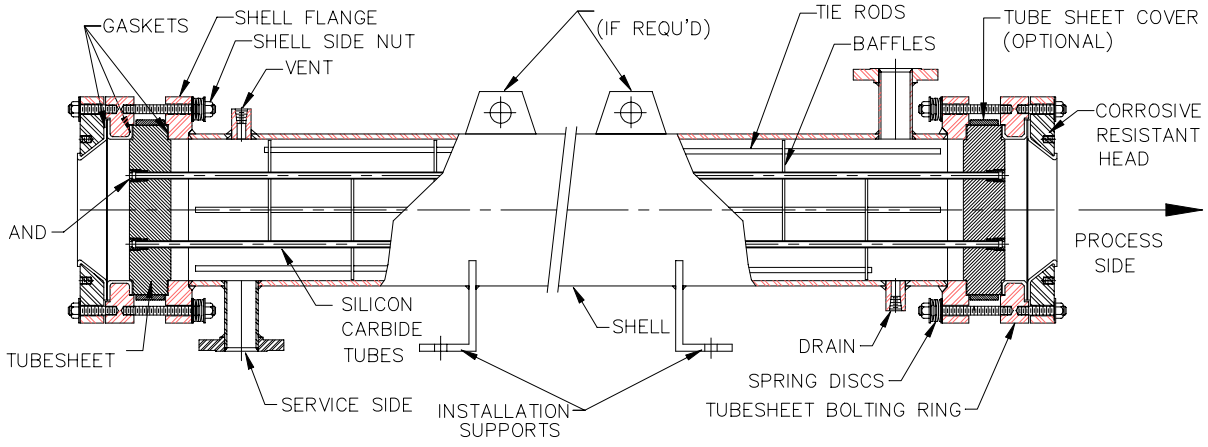
INTRODUCTION

In order to ensure a reliable and durable operation of your heat exchanger, we recommend that you follow these instructions carefully.

The installation, operation and maintenance instructions which follow are believed to be reliable general guidelines for usage of the equipment described herein. Polytube® Silicon Carbide heat exchangers are uniquely designed corrosion resistant units consisting of silicon carbide tubes attached to a tube sheet (generally teflon) and placed inside a steel shell. The process fluid flows in the silicon carbide tubes and the service fluid flows around them in the steel shell. Silicon carbide is practically inert to all chemicals. For specifics on corrosion resistance, consult Carbone of America's corrosion guide or one of our representatives.

CARBONE OF AMERICA (LCL) Ltd. expressly disclaims any warranty, expressed or implied, of fitness for any specific purpose in connection with the information contained herein.

Unless otherwise specifically provided in the contract of sales, CARBONE OF AMERICA does not provide project engineering or process design and, accordingly, the information presented herein is general in nature and should not be considered applicable to any specific process or application. While equipment is designed and manufactured in accordance with applicable codes and good manufacturing practices, it is the responsibility of the user to locate and install the equipment and provide those safety and warning devices which are appropriate for the specific application intended by the user.



POLYTUBE SILICON CARBIDE HEAT EXCHANGER TERMINOLOGY
(HORIZONTAL INSTALLATION SHOWN)

FIGURE "1"

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1. RECEIVING INSPECTION

All equipment produced by CARBONE OF AMERICA is carefully inspected and hydrostatically tested at the specified test pressure as indicated on the Carbone assembly drawing. The method of packing the exchangers on skids has proven satisfactory over many years, and is approved by the carriers when accepting the units for shipment. However, damage in transit is always possible, and the exchanger should be inspected immediately upon receipt, before removing from the packing skid. Do not give the carrier a clear receipt or put the unit in storage before performing the following :

a) Examine the skid and crating carefully for evidence of damage in transit.
Note: Carbone of America usually installs a "shock watch" device on the packaged shipment which if broken (indicates red in the glass vial) is immediate evidence of mishandling during transit.

b) Visually inspect all nozzles, flanges, support brackets, etc. for damage.

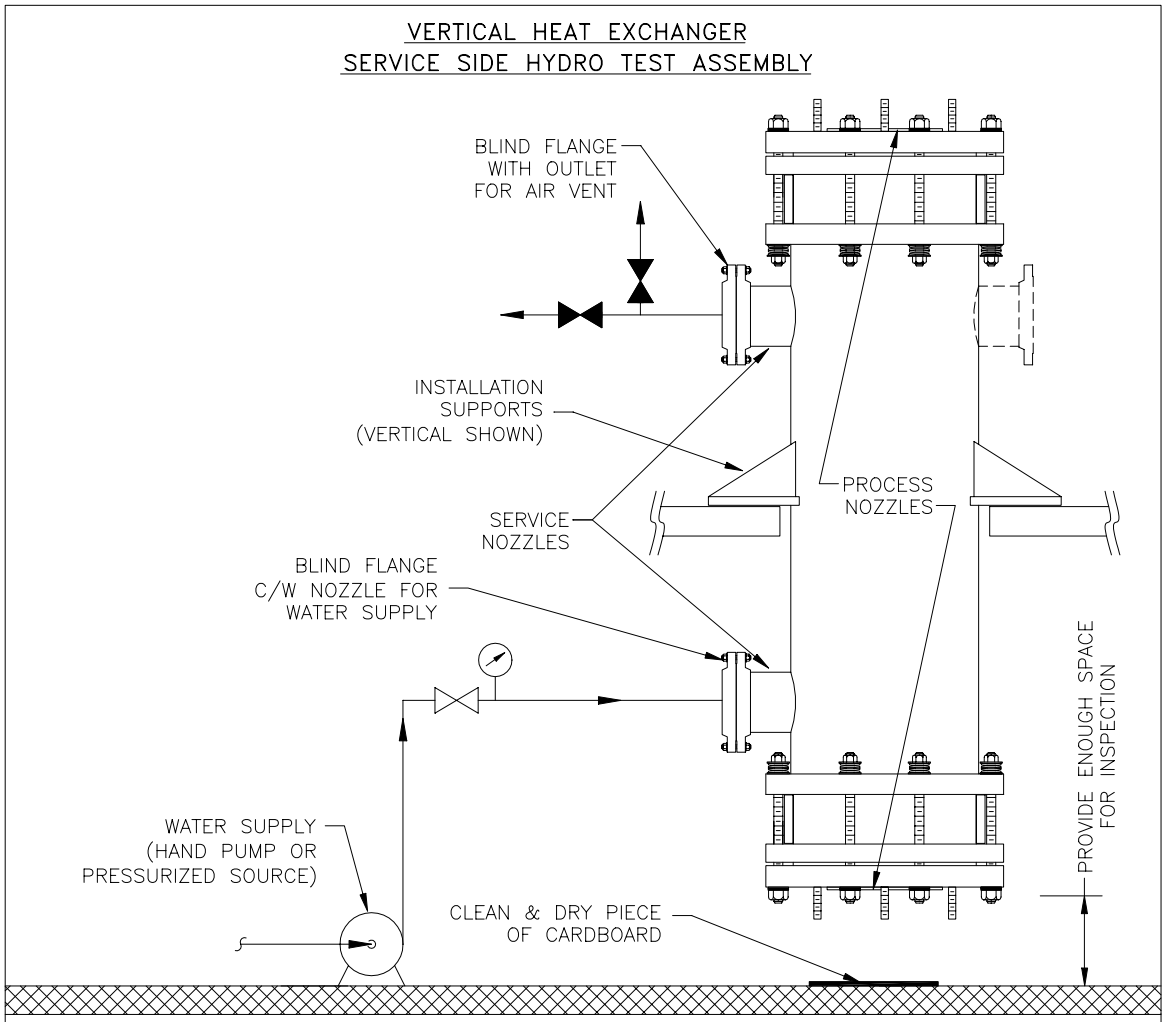

FIGURE "2"

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c) Check the torque of the springs (Belleville washers) at the shell flange, and the torque loading of all other bolts. Retorquing may be necessary due to gasket set during transportation. Refer to your assembly drawing for the proper torque values or heights.

d) perform an initial hydro test by following these steps : (refer to figure 2).

i) Rig and support the unit in a vertical position.

ii) Connect pressure piping & valving to the service nozzles.

iii) Put a dry clean piece of cardboard under the exchanger which will serve as a leak detector.

iv) Fill the shell with water through the service connections. Vent air through an outlet vent valve.

v) Pressurize the service side gradually up to the test pressure noted on the assembly drawing. Check for leaks while under pressure. Pressure should be held for a minimum of one hour. For a multipass process exchanger, the test should last at least 2 hours. If a leak develops, this will show up as drops of water coming out of the bottom of the exchanger. TEST PRESSURE MUST NEVER EXCEED THE DESIGN OR TEST PRESSURE AS MARKED ON THE NAMEPLATE OR ON THE ASSEMBLY DRAWING.

If leaks occur after the preceding procedure, a claim should be filed immediately with the shipper, and Carbone of America should be notified of the problem. Remove the corrosive resistant heads to determine the exact nature of the leak and follow the instructions of steps vi to viii.

If the exchanger is not to be installed immediately, be sure to drain the test water completely in order to prevent freeze damage during cold weather.

vi) If a leak appears between the tubesheet and the shell flange, make sure that the spring discs are at the specified torque value or height (refer to assembly drawing).

vii) If a leak appears at the face of the tubesheet, this would indicate one or several broken tubes. Visually check along the inside of the tubes for damage. Refer to section 4 for tube replacement or plugging.

viii) If a leak appears in the tread of the tube nut or between the I.D. of the tube nut and the O.D. of the silicon carbide tube, the O-rings need to be retorqued. Cut the pressure and torque the leaking shell nuts to the value specified on the assembly drawing. If the leak persists, the torque can be increased by five (5) inch-pounds increments to a maximum of thirty-five (35) inch-pounds.

2. INSTALLATION

a. Handling

The heat exchanger must be handled carefully. It should be lifted either by the support brackets or by lifting lugs (if so provided) attached to the shell. NEVER LIFT THE EXCHANGER BY THE SPRING ASSEMBLIES OR BY THE NOZZLES.

b. Clearance for dismantling

Polytube® heat exchangers can be repaired on site. Unless adequate provisions can be made for taking down the complete exchanger, it is recommended that sufficient clearance be allowed for dismantling and repair. The tube bundle is removable from either end of the exchanger. Minimum clearance should be the length of the exchanger plus one (1) foot (300 mm) for at least one end for tube bundle removal.

c. Foundation

Any concrete foundation or floor or structure must be adequately designed to support the Polytube® heat exchanger and its contents. The weight of your heat exchanger either empty or full of water is indicated at the beginning of this manual and on the assembly drawing.

d. Vertical installation

Vertical installation is usually recommended. This position minimises air entrapment. The Polytube® may be supported on any rigid steel frame or stand suitable for the loads by its integral supports.

e. Horizontal installation

The Polytube® may be operated horizontally only if originally designed for this arrangement. Special provisions must be made at the design stage to maximize draining and venting of the unit.

The Polytube® may rest on suitable saddles without bolting the shell directly to the saddles. This allows for free expansion of the shell. For fixed horizontally mounted exchangers, one support has drilled mounting holes and the other support has slotted holes (refer to figure 3). Tighten and "fix" the bracket with the "holes" and use double nuts at the slotted bracket so there is clearance between the bolts and the slotted holes to allow the bracket to slide as the shell thermally expands and contracts.

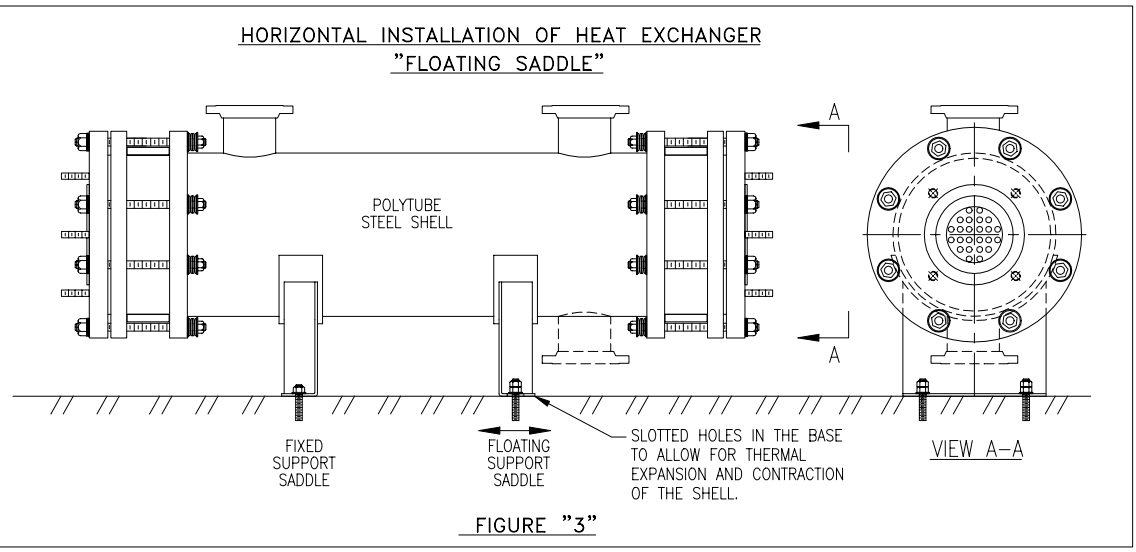

FIGURE "3"

f. Levelling

Polytube® heat exchangers should be set level and square so that all piping connections may be made without excess force. The use of expansion joints (see sections h and i for details) is recommended.

g. Dirt removal

The entire piping system connected to the heat exchanger should be isolated and then cleaned and flushed prior to the start of operation to prevent plugging of tubes or damage to the heat exchanger. The use of strainers or settling tanks in the pipe line up-stream of the exchanger is strongly recommended.

h. Process Piping (see figure 1)

Piping to Polytube® corrosive resistant heads connections should be planned carefully to prevent undue stresses from being transmitted to the exchanger. TFE expansion joints, installed as close to the exchanger as possible, are recommended to isolate the unit from vibration, misalignment and thermal expansion of the piping or other loads which can impose stress on the heat exchanger. Carbone of America can supply Armylor® corrosion resistant TFE expansion joints for this purpose. Contact Carbone of America for assistance in sizing and selection. The heat exchanger is not a pipe support. Make sure to respect the torque values indicated on the assembly drawing when connecting the process piping to the heat exchanger.

Note: Use gaskets which are easy to seal and require low torque values for process nozzle connections. Woven PTFE tape gaskets or suitable elastomeric gaskets are recommended.

i. Shellside Piping / Service (see figure 1)

Piping connections can be made to the steel shell using standard pipefitting techniques. (Refer to piping handbook by Crocker and King). Expansion joints, installed as close to the exchanger as possible, are recommended to isolate the unit from vibration, misalignment and thermal expansion of the piping or other loads which can impose stress on the heat exchanger. Steam lines should be properly trapped and provisions made to drain all water legs which might develop in the supply line on shutdown. Use slow opening valves to prevent water or steam hammer. Water or steam hammer can cause damage and create a leak between the process and the service fluids. Automatic control valves, when closed or almost closed, can allow steam to enter the exchanger without providing enough pressure to discharge the condensate. Therefore, condensate lines should be arranged so there is no back pressure after the trap, and a vacuum breaker should be provided at the highest point in the piping system. This will permit condensate to drain by gravity.

j. Pressure Relief Devices/Thermowells

If the heat exchanger is to be operated under pressure, the installation of pressure relief devices on both process and service sides of the exchanger are recommended or may be required by law. Check with local jurisdictions for laws or codes that apply. Refer to ASME Code Section VIII, Division I for recommendations on these devices. Impervious graphite (Graphilor®) rupture disks are available from CARBONE OF AMERICA to alleviate pressure safely from corrosive process lines.

For added convenience, Graphilor® thermowells can be installed on the inlet and outlet process piping to permit temperature indication and transmission. Carbone of America can supply these thermowells if required.
Installation of a valved bypass lined across the heat exchanger nozzles will permit disassembly of the exchanger itself without shutting down the line if multiple heat exchangers are plumbed in series or parallel.

k. Disc Springs

Disc springs are used at the shellside flange bolting to keep the PTFE tubesheets under load. Thus, the disc springs allow for thermal growth and cold flow of the PTFE tubesheet, while maintaining proper gasket compression. The correct compressed height for the disc springs is shown on your specific assembly drawing. Refer to figure 4 for detail.

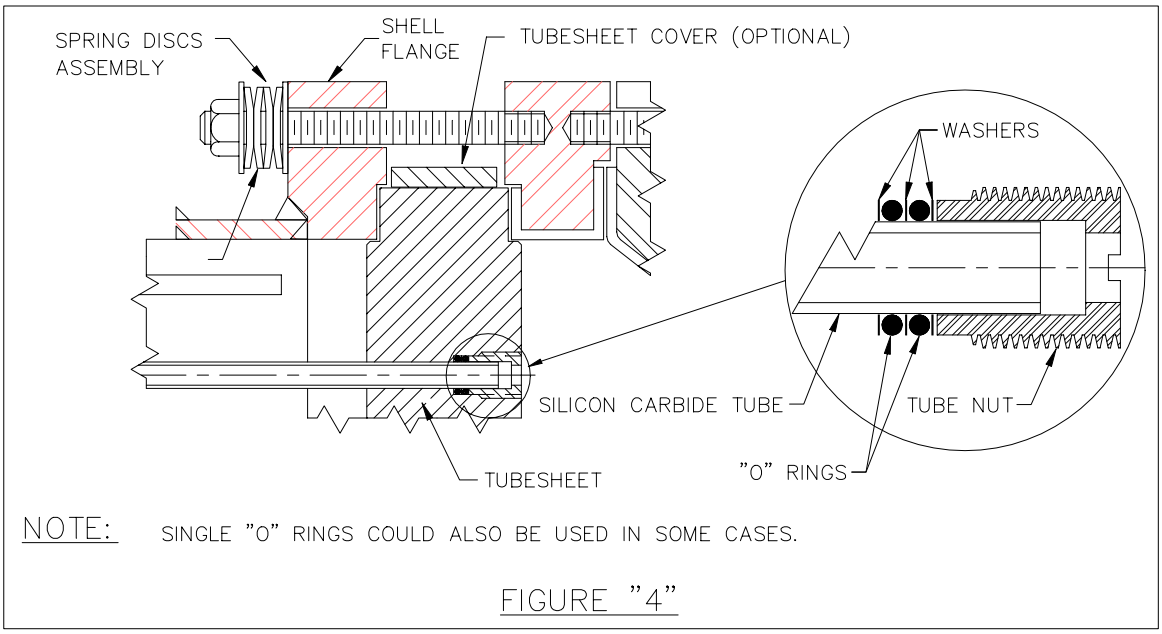

FIGURE "4"

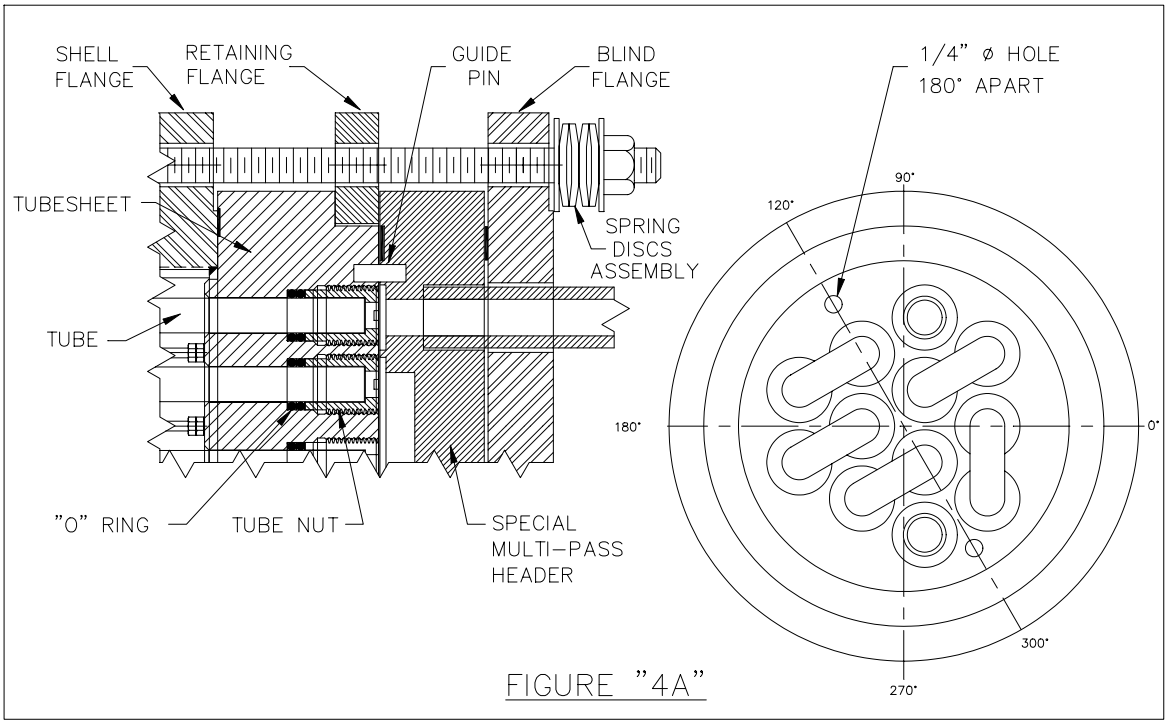

FIGURE "4A"

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3. COMMISSIONING AND OPERATION

a. Warnings

i) **Danger:** Do **not** operate the unit at pressure or temperature conditions exceeding those specified on the nameplate or the assembly drawing. Exceeding the values could result in an explosion and bodily harm. (Note: The lowest value listed must be respected. Note that the process side rating can be different from the service side rating).

ii) **Danger:** Do **not** use compressed air to clean the unit if fluids normally handled are flammable. Dissipating these fluids could result in fire and bodily harm.

iii) PREVENT BOIL UP OF PROCESS FLUIDS IN THE HEAT EXCHANGER. This can cause excessive fouling in the tubes and may result in damage to internal parts of the exchanger. Provide safety interlocks with the control system. If the process fluid flow stops for any reason, the steam or thermal oil must shutdown automatically.

iv) Inspect steam traps periodically to prevent backup of condensate in the exchanger. Condensate flooding will reduce the performance of the heat exchanger.

v) Refer to the Carbone exchanger assembly drawing for proper bolt torque information when tightening or adjusting nozzle and shell flanges. Always use Carbone TFE expansion joints at or near corrosive resistant head connections to lessen nozzle loadings. Expansion joints if used should always employ safety shields to avoid splashing in case of rupture. Safety shields are available from Carbone of America.

vi) Torquing of any section of the exchanger must be done when the unit is shut down and “cold”.

vii) CAUTION : The O-rings originally provided with the Polytube® have been selected for a specific chemical service. If the Polytube® is used for a different chemical substance, different O-rings might be required.

b. Commissioning

i) If you are commissioning a new unit or one that has been re-assembled for service, make sure that all nuts and springs (spring discs) are at the design torque value (height). Torque values are indicated on the assembly drawing. Gaskets may compress (or cold flow) over time. This will cause a loss of compression of the springs (spring discs). The compression of the springs (spring discs) should thus be checked periodically and always after the 1st few thermal cycles.

ii) To start the unit, run the cold fluid first. Open valves slowly to flood the unit and to vent all air before allowing full flow. Once steady flow conditions are reached, introduce the hot fluid in the same manner.

iii) For steam service; the steam trap bypass valve should be open when starting a steam-heated unit. This valve can be closed when a steady flow of steam has been attained. STEAM OR HOT THERMAL OIL MUST NEVER BE ALLOWED TO CIRCULATE ALONE IN THE EXCHANGER. If the flow of the cold fluid is stopped for any reason, the steam or hot thermal oil must be stopped automatically. (We recommend a flow switch interlock).

iv) Operation of all valves must always be slow and gradual to avoid water or steam hammer. Automatic valves require special attention. Upon shut down, the steam or thermal oil valve should be reset to the closed position to prevent a wide open position upon restart and possible “hammer”.

c. Shutting down the Polytube®

The hot fluid should be gradually shut off first in all cases. If it is necessary to stop the circulation of the cooler medium, the hot medium should also be stopped immediately or the Polytube® bypassed accordingly. Once the hot fluid has stopped, let the cold fluid circulate for several minutes in order to stabilize the temperature and then close the valve gradually. For prolonged shutdowns, fluids should be drained from the unit to prevent corrosion, crystallization or precipitation. In addition, in cold environments where freezing may occur, all fluids must be drained. As indicated above, condensation in a steam system should also be drained to prevent water hammer, both when starting up and when shutting down the unit.

4. MAINTENANCE

a. Fouling

The Polytube® heat exchanger should be periodically cleaned by mechanical or, preferably, chemical means to keep fouling (sludge or scale formation) to a minimum. This fouling greatly reduces the efficiency of the Polytube®, even though an estimated fouling factor is included in the original design. In addition to the reduction in efficiency, there is generally a marked increase in the pressure drop across the process & service nozzles. The silicon carbide tubes can be cleaned with a wide assortment of acids and bases. Contact Carbone of America if there are any questions on the cleaning agent. The shell, which is generally carbon steel, should be cleaned taking into account the corrosion resistant properties of steel. The different chemical and mechanical means of cleaning the exchanger are explained in the following sections.

b. Carbone Factory Service

Carbone of America provides complete heat exchanger servicing, including complete unit overhauling at its Vaudreuil-Dorion, Quebec and Salem, Virginia facility and other facilities worldwide.

Carbone of America can also provide the services of a field service technician or engineer to supervise in an advisory capacity, customers' routine heat exchanger cleaning and maintenance.

c. Chemical Cleaning

Note: Make sure that chemicals listed below are compatible with your process piping system and tubesheet and O-rings.

i) Sulfuric Acid Cleaning (Process side)
- Feed and flood 10% to 15% sulfuric acid (H_2SO_4) solution (by weight) through process side.
- Bring solution to boil by introducing steam on the shell side. Do not exceed the pressure and temperature rating of the exchanger. (We usually recommend 15 psig (100 kPag) steam or lower).
- Stop cycle after two to four hours and drain sulfuric acid solution.
- Rinse heat exchanger for 30 minutes with clean water.
- Check torque values of connections and return unit to normal operation.

ii) Caustic Cleaning (Process side)
- Same as above except use a max. 15% caustic solution (NaOH); we recommend a 10 % caustic solution.
- Rinse heat exchanger with clean water, as above and check torque values of connections.
- Return unit to normal operation.

iii) Other solutions such as organic solvents can be used to clean Polytube® exchangers, but it is strongly suggested that the customer be thoroughly familiar with the properties of the particular solvent, and with the chemical manufacturer's recommended precautions. Carbone of America can only make recommendations regarding the compatibility of the solvent with the tubesheet and O-rings and not the surrounding piping.

iv) Chemical cleaning of the service side

Water scale and lime can accumulate on the service side of the exchanger. Many cleaners are available commercially to remove these deposits without any detrimental affect on the steel portions of the exchanger.

Refer to the chemical supplier's instructions for these cleaners for proper cleaning procedures. **Once again, verify the compatibility of these cleaners with the tubesheet and the O-rings.**

d. Mechanical Cleaning

Mechanical cleaning is generally used only for the inside of the tubes. The corrosion resistant heads must be removed. Dismantling and re-assembly will be explained in the following sections of this manual. Several techniques can be used to clean the exchanger tubes. Precautions must be taken to avoid damage to the tubes, tube nuts and tubesheet.

i) Rodding
This method consists of inserting by hand a steel rod of a diameter slightly smaller than the inside diameter of the tubes to clean. This should remove deposits.

ii) Brushing (or Brush Drilling)
This is the recommended method. The tubes are cleaned using a plastic (never metallic) cylindrical brush (tube cleaner) which can be attached to a pneumatic drill and used either wet or dry. Special care must be taken not to damage the tubesheet and tube nuts.

iii) Pressure cleaning (or water blasting)
The channels are cleaned using long nozzles and a warm water pressure cleaning machine (below 1500 psi, 10300 kPa).

Regardless of which method is used, an hydrostatic test of the Polytube® is required after cleaning. Refer to section 1 and figure 2 for procedure.

e. Disassembly of the Polytube®

Caution: Silicon carbide tubing is fragile and can suffer mechanical damage if mishandled, dropped or subjected to bending loads. Therefore, take extreme care when disassembling the bundle from the shell.

Note: It is not necessary to remove the bundle to replace tubes. Refer to Section g (page 15) for this procedure.

Material Required

a) Required quantity of silicon carbide tubes.
b) Required quantity of replacement O-rings.
c) Required quantity of replacement tube nuts.
d) Required quantity of tube plugs.
e) Torque screwdriver and tube nut bit.
f) Tube push rod (see Figure 5), at least length of tube + 12" (300mm), made of wood or plastic, slightly smaller in diameter as the tubing O.D., must be smooth and ends slightly chamfered to avoid scratching the PTFE tubesheet.
g) PTFE based lubricant.

Procedure

For shellside mechanical cleaning or inspection, it will be necessary to remove the bundle from the shell. Refer to your assembly drawing for specific construction details, and Figure 1 for general arrangement. The suggested dismantling procedure is the following :

i) If possible, move the exchanger to a convenient working area, where hoist or crane facilities are available.
ii) Remove both corrosive resistant heads. Do not loosen the spring discs nuts and do not remove the tubesheet bolting ring at this time. Multi-pass process exchangers have special corrosion resistant heads that can only be installed in a specific position. These special heads have guide pins to insure the correct installation position. They can also have special multipass baffle rings that are installed inside the bolting ring. A special multi-pass corrosion resistant head could completely block the SiC tubes if not installed properly. Refer to figure 4A on page 7 for more details.
iii) Remove all the tube nuts from both tubesheets.
iv) Using the tubing push rod, push all the silicon carbide tubing through the first tubesheet until they are past the back side of the first tubesheet.
v) Remove the tubesheet bolting ring on the first tubesheet by loosening the spring-loaded shellside bolting.
vi) The first tubesheet and tubesheet cover can now be lifted off the unit.
vii) Using the tube push rod, push each tube through the second tubesheet until the tubes clear the back side of the second tubesheet.
viii) Remove the second tubesheet bolting ring by loosening the spring-loaded shellside bolting.
ix) Remove the second tubesheet and tubesheet cover from the shell.
x) Carefully remove each tube, one at a time, from the tube bundle. Do not apply any lever-arm loads to the tubes as they are being removed.
xi) Set the tubes aside in a protected area, taking care not to drop them or chip or scratch the tube ends during handling.
xii) Remove the baffle cage (subassembly of baffles and tie rods) from inside the shell.
xiii) Remove the O-rings from the tubesheets. On a double O-rings assembly, both O-rings are not always of the same material. Make sure to store them separately and properly identified if they will be re-used to put them back at the right position. They can look identical.

xiv) The disassembly is now complete. Clean or repair any of the shellside components, as required.

f. Reassembly of the Polytube®

After cleaning or repairs have been completed, the heat exchanger can be reassembled by observing the following steps :

i) Install the baffle cage inside the shell. Orientate the baffle cage, in relation to the shell nozzles, as shown on the assembly drawing.

ii) Install tubes, one at a time, into the baffle cage. To facilitate the tube insertion it is recommended to use a tube push rod (not threaded) as shown on figure 5. It is important to fix the insertion cone to the rod as shown in order not to impose any effort to the tube during insertion. If the tubes have not been cleaned, clean the tube ends with acetone after they are in place. Lubricate 2" of all tube ends with PTFE based lubricant.
Position the tubes so that they are 1 inch inside the shell flange face of the second tubesheet end of the unit.

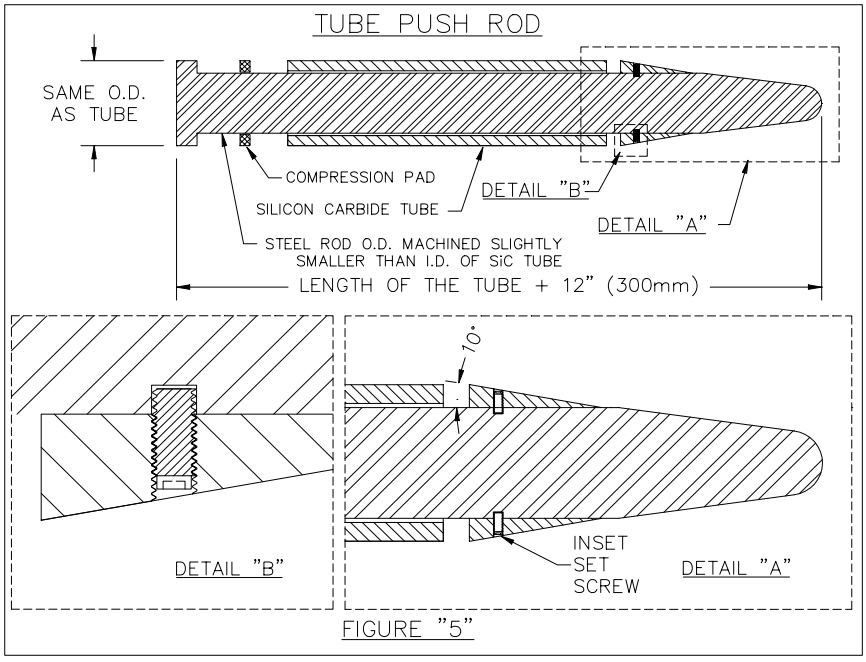

FIGURE "5"

iii) Set the second tubesheet in place on the shell, making sure the tubesheet cover is in place.

iv) Install the second tubesheet bolting ring, and snug up the spring-loaded shellside bolting only enough to firmly hold the tubesheet.

v) Test the tubesheet orientation by sliding 8 to 12 tubes through the proper holes in the second tubesheet.

1) **Note:** It may be necessary to rotate some tubes to get them into the tube holes. You can use the insertion rod again for this operation.
If all the test tubes are not aligned, push any that are in place back through the tubesheet, and bump or jog the tubesheet to re-orient it in relationship to the tube bundle.

vi) When the proper orientation is obtained, tighten the shellside bolting to the stated spring height on the assembly drawing. Observe the staggered tightening pattern shown in Figure 6.

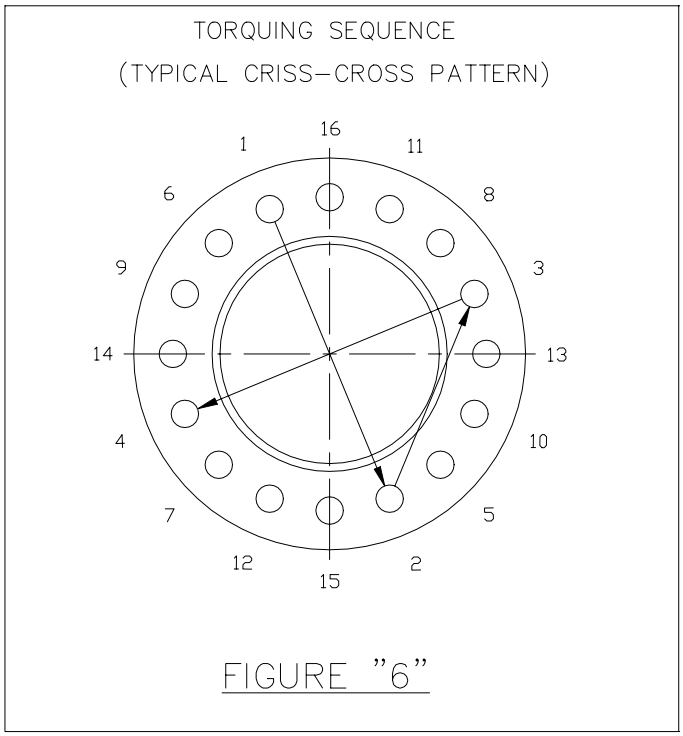

FIGURE "6"

vii) Slide all the tubing through the second tubesheet towards the outside of the exchanger and position the ends at the first tubesheet, 1 inch inside the face of the shellside flange.

viii) Repeat steps "iii through viii" for the first tubesheet, and position the tubes evenly inside the tubesheets.

ix) Apply the PTFE based lubricant to the new or cleaned O-rings.
   1) If the old O-rings are to be reused, clean them in warm soapy water, or a solvent compatible with the O-ring material. Inspect them for cuts, signs of wear, etc. and discard any questionable ones.
   2) **Note:** Many O-ring elastomers are not compatible with solvents such as acetone. Make sure the solvent used (if not soapy water) is acceptable.
   3) Different elastomeric material can be used on a double O-ring arrangement. Make sure to use the right one at the right position. Refer to the assembly drawing for details.

x) Stretch the O-rings over the O.D. of the tube and slide them into place. Install the tube nuts and, using the torque screwdriver, torque them to the value shown on the assembly drawing.

xi) Test the unit by applying a shellside hydro-test, but not higher than the value shown on the assembly drawing (refer to section 1). If time permits, it is recommended that the unit be allowed to set for 12 to 24 hours to allow the O-rings and tube nuts to "set or cold flow" as required. At the end of that time, retorque to the original value, and reapply the shellside hydro-test.

xii) Install the heads by torquing down the tubeside bolting. It is important that all bolted joints be tightened uniformly and in a diametrically staggered pattern as illustrated in Figure 5. Refer to your specific assembly drawing for proper torque values. Multi-pass corrosion resistant heads must be installed using the guide pins. Refer to section e, ii and figure 4A for details.

xiii) Perform a tubeside hydro-test, but not higher than the value indicated on the assembly drawing.

g. Tube replacement

Tubes can be replaced in the field, without removing the bundle from the shell. Replacement will be easier with the heat exchanger in a horizontal position and with proper tools (tube push rod, torque screwdriver, etc.).

Remove both corrosive resistant heads to allow access to the tubesheets.

Do not loosen the shellside bolting or remove the tubesheet bolting ring. Using the torque screwdriver, remove the tube nuts from both ends of the silicon carbide tube which is to be replaced.

Push the silicon carbide tube through one of the tubesheets with the tube push rod so it can be grasped at the other end and pushed and pulled from the exchanger. Remove the O-rings from the tubesheet gland.

Slide the new tube into place in the exchanger, and clean the ends of the tube with suitable solvent or warm soapy water, once it is in place (refer to section f for tube insertion technique).

If the old O-rings are to be reused, clean them in warm soapy water or a solvent compatible with the O-ring material. Inspect them for cuts, signs of wear, etc. and discard any questionable ones.

Note: Many O-ring elastomers are not compatible with solvents. Make sure the solvent used (if not soapy water) is acceptable.

Apply the PTFE based lubricant to approximately two inches of both ends of the new silicon carbide tube. Apply the lubricant to the O-rings also.

Stretch the O-rings over the O.D. of the tube and slide them into place. Install the tube nuts, and using the torque screwdriver torque them to the value shown on the assembly drawing.

Test the repair by applying a shellside hydro-test, but not higher than the value stated on the assembly drawing.

h. Tube Plugging

If replacement tubes are not available, or other conditions warrant it, tubes can be plugged off in the following manner :

i) Follow the steps under Tube replacement (section 4g), until the tube has been removed from the shell.
ii) Clean the O-rings per Section 4g or use new ones and install them on the shoulder of the tube plugs, using the PTFE based lubricant.
iii) Install the tube plugs into the tubesheet, and using the torque screwdriver, torque them to the value shown on the assembly drawing. Refer to Figure 7 for the completed plugged tube joint.
iv) Test and reassemble the heat exchanger as described in previous sections.

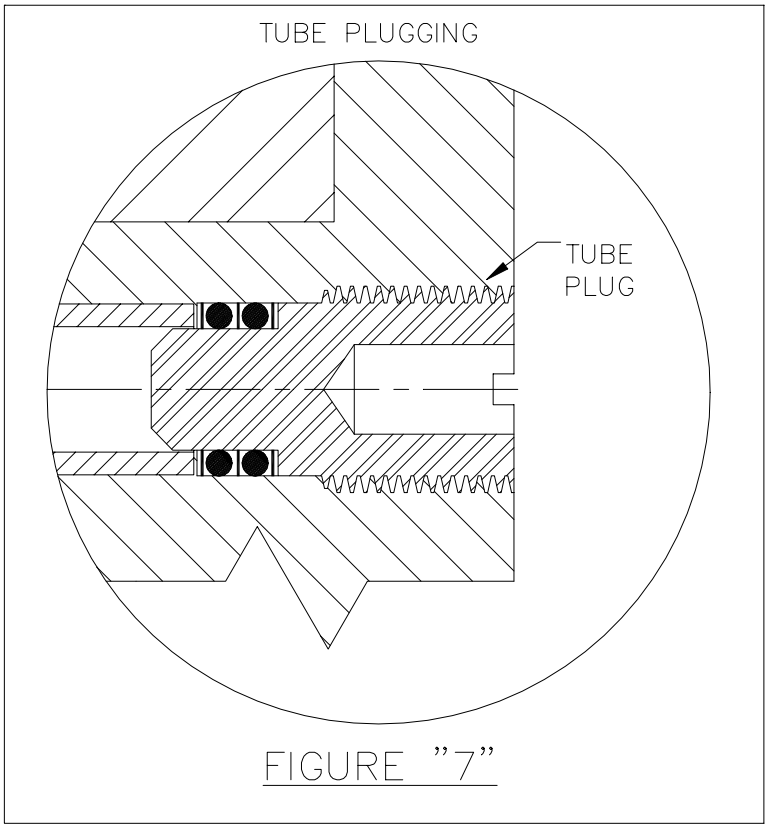

FIGURE "7"

5. SPARE PARTS

When ordering spare parts, please refer to the heat exchanger drawing supplied with the unit and order parts using the full part number. The assembly drawing number should also be given as a reference. This will ensure that the parts ordered will be the correct items and material of construction for your heat exchanger. As a minimum, one complete set of gaskets should be stocked at all times for each exchanger in service.

For replacement parts, field servicemen or exchanger repair call your local Carbone representative, or the factories direct at :

CARBONE OF AMERICA (LCL) LTD.
225 HARWOOD BLVD
VAUDREUIL-DORION, QUEBEC
J7V 1Y3
TELEPHONE: (450) 455-5728
FACSIMILE: (450) 455-5052

CARBONE OF AMERICA CORP.
540, BRANCH DRIVE
SALEM, VA 24153
U.S.A.
TELEPHONE: (540) 389-7535
FACSIMILE: (540) 389-7538

Spare Parts List recommendation :

Item	Description	Quantity
a	Torque screwdriver & bit (installation tool)	1
b	Tube push rod (installation tool)	1
c	Set of “O” rings, process	Quantity indicated on drawing
d	Set of “O” rings, service	Quantity indicated on drawing
e	Set of TFE washers	Quantity indicated on drawing
f	Set of shell gaskets	Quantity indicated on drawing
g	Tubenuts	10 to 20 % of total quantity
h	Tubeplugs	10 to 20 % of total quantity
i	Replacement tubes	10 to 20 % of total quantity

6. CLEANING CARBONE EQUIPMENT BEFORE RETURNING IT TO CARBONE FOR REPAIRS.

Employee safety and the strict adherence to OSHA, EPA and other safety and pure air and water regulations are primary concerns to CARBONE OF AMERICA. To repair equipment in a safe and expedient manner, it is mandatory that the equipment be returned in a thoroughly cleaned condition.

It should be noted that there are no facilities at CARBONE OF AMERICA to discharge effluent from dirty equipment.

A Returned Equipment Questionnaire and Material Safety Data Sheets must be completed by the customer and sent prior to returning equipment to Carbone of America. Failure to comply may cause delays in processing the equipment or possible rejection of the equipment, with return of it to the customer at his expense. In general, the following should be carried out sequentially:

a. Remove all external insulation.

b. Clean equipment exterior and interior. The inside and outside of the equipment and related accessories must be free of any residue or other contaminants which may be toxic, flammable, explosive and irritating at any temperature from ambient up to and including welding temperatures.

c. Flush shell and tubeside of the exchanger to remove all heating or cooling medium and product residue. A thorough flushing of the unit with water or a non-harmful solvent is required.

d. All materials/items removed from the vessel should not be returned to CARBONE OF AMERICA. They should be disposed of in a manner consistent with the customer's safety or salvage policies.

e. Contact CARBONE OF AMERICA for an applicable Returned Equipment Questionnaire. A Material Safety Data Sheet will be required as well. Complete the forms and return them to CARBONE OF AMERICA.

f. After our review of the completed Questionnaire and Material Safety Data Sheets, Carbone will send you a "Return Authorization Tag" that you should attach to your unit before returning it to us.

7. ASSEMBLY DRAWINGS (attached) & NOTES