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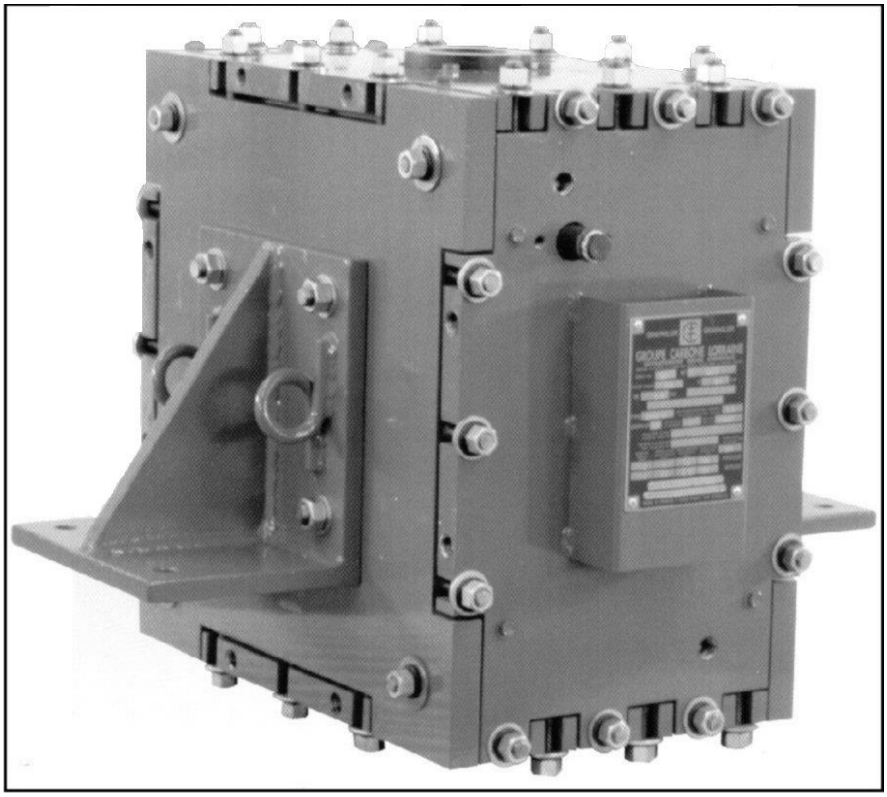
GRAPHILOR® CUBIC HEAT EXCHANGERS
MODEL NK

INSTALLATION, COMMISSIONING & MAINTENANCE MANUAL



REF: CUBIC.ED

GRAPHILOR® CUBIC HEAT EXCHANGERS
MODEL NK

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

Model #: _____

Type of impregnation: _____

MERSEN USA drawing No:_____

Customer/Ultimate owner _____

& address: _____

_____

P.O. number: _____

Project No.: _____

Equipment tag number(s): _____

Vessel Serial numbers: _____

Overall dimensions: _____

Weight empty: _____

Weight full of water: _____

Rev. No.	Document Ref : CUBIC.ED	Date	Written by	Checked by
B	Added new section 8, changed Carbone to Mersen USA	FEB 22, 2016	TR	RD

IMPORTANT INFORMATION FOR PROPER OPERATION OF MERSEN USA CUBIC GRAPHITE HEAT EXCHANGERS MODEL NK HEATED WITH STEAM OR THERMAL OIL.

1. PROPER SEQUENCE ON START UP:

A. Start acid circulation first.
B. Gradually open steam (or thermal oil) valve, increasing flow rate to design conditions over a period of approximately 5 minutes. Prevent steam (or thermal oil) or water hammer.

2. PROPER SEQUENCE ON SHUTDOWN:

A. Shut down steam (or thermal oil) flow first. Prevent steam (or thermal oil) or water hammer.
B. Allow acid to circulate several minutes in order to stabilize the temperature in the exchanger, then shut off flow.

3. PREVENT BOIL UP OF ACID IN THE HEAT EXCHANGER.

This can cause excessive fouling in the blocks and may result in damage to internal parts of the exchanger. Provide safety interlocks – If acid flow stops for any reason the steam (or thermal oil) must shutdown automatically. Upon shut-down, the steam (or thermal oil) valve should be reset to the closed position to prevent auto wind up or a "wide open position" upon restart.

4. OTHER GENERAL NOTES:

. Never exceed the design conditions labelled on the exchanger nameplate.
. Inspect steam traps periodically to prevent backup of condensate in the exchanger; this will reduce the performance of the exchanger.
. Refer to the MERSEN USA exchanger assembly drawing for proper bolt torque information when tightening or adjusting nozzle and shell flanges. Damage to graphite parts may result if over torqued! Always use MERSEN USA TFE expansion joints at or near graphite nozzle connections to lessen nozzle loadings.

5. The process heads are steel assembly plates with a Graphilor® liner. The Graphilor® liner is not bonded to the steel plate. The Graphilor® liner is attached to the steel plate by only a few bolts (the number of bolts depends on the size of the heads) called "Process alignment bolts". THESE BOLTS MUST NEVER BE TORQUED ABOVE 5 FT-LBS OR ANY SPECIFIED VALUE ON THE ASSEMBLY DRAWING. EXCEEDING THIS VALUE WOULD AUTOMATICALLY RESULT IN CRACKING THE GRAPHILOR® LINER.

In the case of an interchanger, this is true for all four (4) heads.

READ AND UNDERSTAND THE INSTRUCTION MANUAL PROVIDED WITH THE EXCHANGER.

FOR FURTHER ASSISTANCE, CONTACT YOUR LOCAL MERSEN USA REPRESENTATIVE OR: 1-800-839-7535 (or direct 1-540-389-7535) (IN THE USA ONLY) OR PHONE 1-450-455-5728 (IN CANADA)

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INTRODUCTION

The model NK exchanger consists of one solid Graphilor® block held in compression between six steel heads. This block has two circuits of holes drilled perpendicular to each other serving as process and service circuits. The service heads are generally made of fabricated steel. The process heads are lined with Graphilor® for corrosion resistance. The model NK heat exchanger is ideal for interchanger situations since all four heads can be lined with Graphilor®. This robust and compact type of construction has become the industry standard for many corrosive process applications worldwide and will continue to do so for many years to come. For specifics on corrosion resistance, consult MERSEN USA's corrosion guide or one of our representatives.

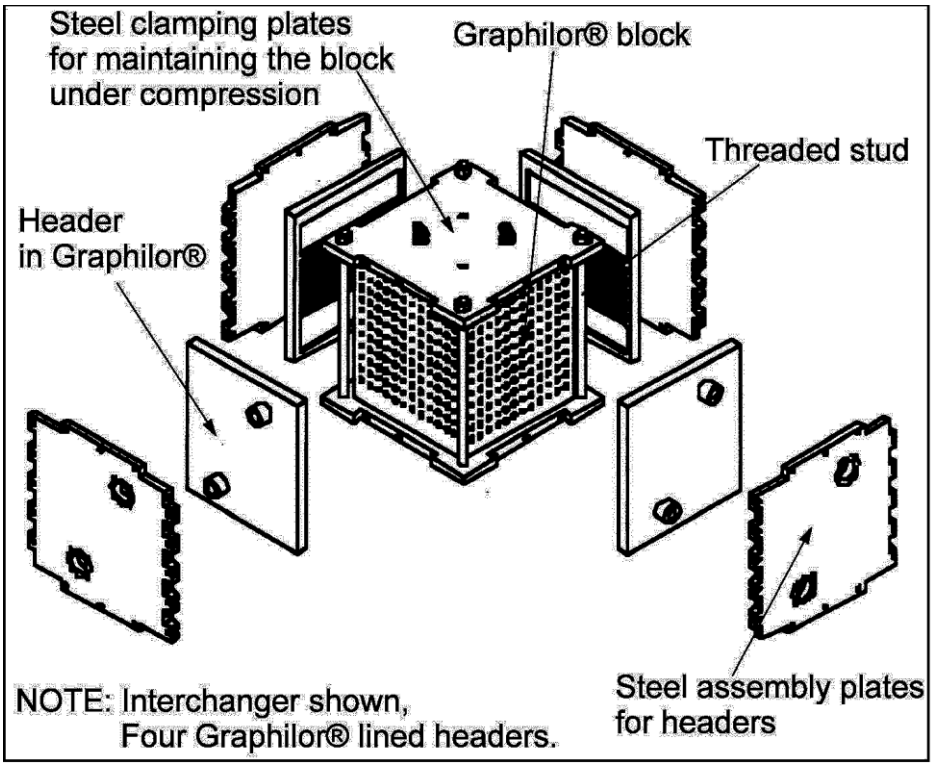
The installation, operation and maintenance instructions which follow are believed to be reliable general guidelines for usage of the equipment described herein. In order to ensure a reliable and durable operation of your heat exchanger, we recommend that you follow these instructions carefully. **MERSEN USA 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, MERSEN USA 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.

1. TERMINOLOGY

Refer to Figure 1 & try to familiarise oneself with the model NK terminology

FIGURE 1



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2. RECEIVING INSPECTION

All equipment produced by MERSEN USA is carefully inspected and hydrostatically tested at the specified test pressure as indicated on the MERSEN USA 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: MERSEN USA 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.

c) Check the torque loading of the bolts. Re-torqueing may be necessary due to gasket set during transportation. Refer to section 5f) the proper torque sequence and refer to your assembly drawing for the proper torque values.

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

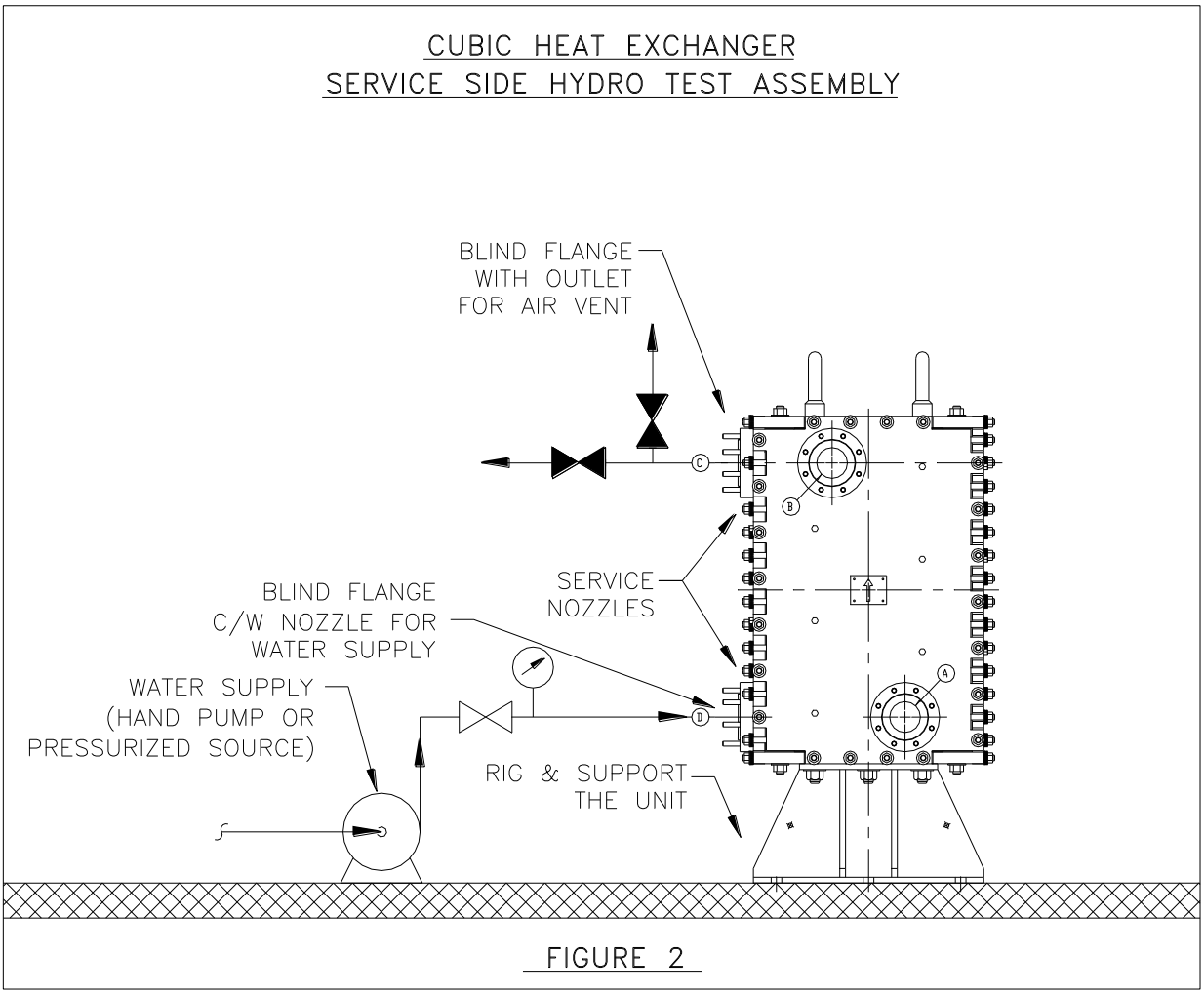

FIGURE 2

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i) Rig and support the unit in a vertical position and remove wood protection from graphite process nozzles and service nozzles.

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

iii) Put a clean and dry piece of cardboard all around the exchanger, under the head gaskets to act as a leak detector.

iv) Fill the service circuit 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 three hours. Expect 2 to 10 psi (14 to 70 kPa) pressure drop over time dependant on test apparatus.

If a large leak develops, this will show as water fills the bottom of the process side up to the nozzle level.

For a very small leak it would take too long to fill the bottom of the exchanger. In any case, it is possible to monitor the rate of the pressure drop on the process side. A decreasing rate would indicate compressing trapped air. Another way is to monitor the amount of water required to maintain the test pressure. Once again, a decreasing water flow indicates compressing entrapped air.

In order to evacuate as much air as possible from the exchanger before the test, circulate water through the exchanger for several minutes before closing the outlet valve.

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 MERSEN USA should be notified of the problem.
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) Use the bottom drain plug to completely drain the exchanger once the test is over.

3. 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 top assembly steel plate. NEVER LIFT THE EXCHANGER BY THE NOZZLES.

b. Clearance for dismantling

For installations where maintenance is to be provided directly at the installation point, minimum clearance is required around the exchanger to remove and handle the process and service heads. Sufficient lifting equipment (chain block) is also required above the exchanger. Otherwise, the entire unit must be removed to allow for maintenance in the shop or elsewhere.

c. Foundation

Any concrete foundation or floor must be adequately designed to support the NK 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.

A base structure must be designed to support the exchanger and also to eliminate movements or moments caused by the hydraulic thrusts of the process and service fluids.

d. Levelling

NK 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 f and g for details) is recommended.

e. 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 holes 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.

f. Process Piping (Nozzles A & B on figure 3)

Piping to Graphilor® header process nozzle 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. MERSEN USA can supply Armylor® corrosion resistant TFE expansion joints for this purpose. Contact MERSEN USA 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. Torques exceeding the indicated values can crush or crack the graphite and create unwanted process leaks.

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.

g. "Service" Piping (Nozzles C & D on figure 3)

TYPICAL PIPING CONNECTIONS
FOR SUPPLY AND RETURN NOZZLES ON SAME HEADER

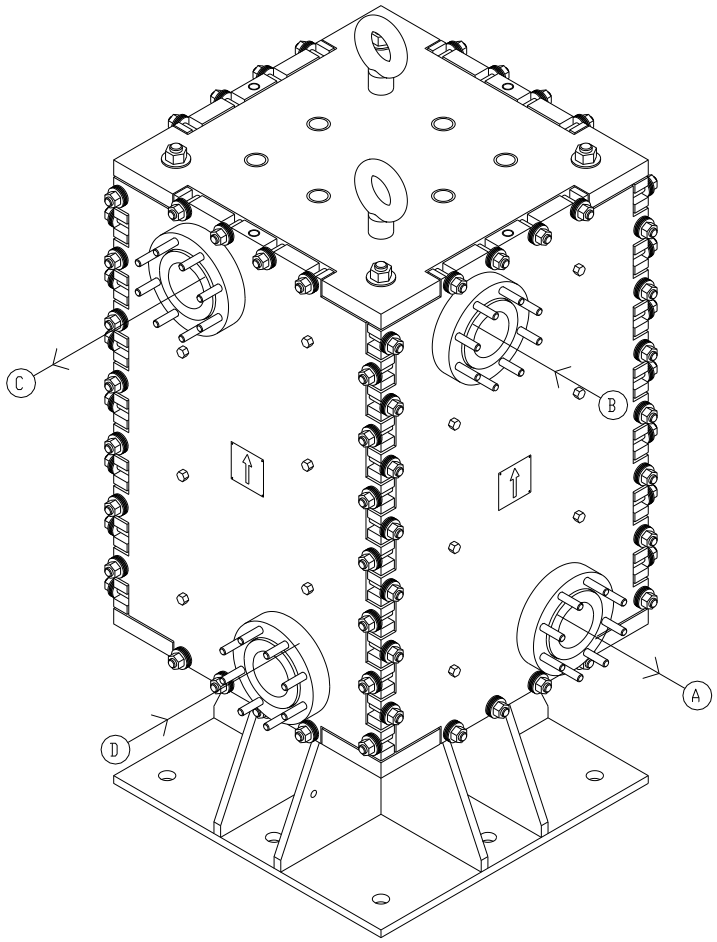


FIGURE 3

Piping connections can be made to the steel service plate 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 the gaskets to blow out and create a leak. 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 backpressure 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.

h. 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 MERSEN USA 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. MERSEN USA 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.

4. 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 block 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 MERSEN USA exchanger assembly drawing for proper bolt torque information when tightening or adjusting nozzle and shell flanges. Damage to graphite nozzles may result if over torqued! Always use MERSEN USA TFE expansion joints at or near graphite nozzles 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 MERSEN USA.

vi) Torqueing of any section of the exchanger must be done when the unit is shut down and “cold”. Never re-torque when the unit is hot. (This will cause overstressing of the graphite as the unit cools down).

b. Commissioning

i) If you are commissioning a new unit or one that has been re-assembled for service, make sure that all nuts are at the design torque value and that the nuts are clean and slightly lubricated. Torque values of the nuts are indicated on the assembly drawing. Gaskets may compress (or cold flow) over time. This will cause a loss of compression of the nuts. The compression of the nuts should thus be checked periodically and always after the 1st few thermal cycles and only when the unit is cold (see section 5 f for details).

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 up 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 NK exchanger

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 NK exchanger 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.

5. MAINTENANCE

a. Fouling

The NK 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 NK exchanger, 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 graphite (process side) can be cleaned with a wide assortment of acids and bases except highly oxidizing ones. Contact MERSEN USA 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. MERSEN USA Factory Service

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

MERSEN USA 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.

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.
- Since caustic can attack impregnated graphite materials above 15% and 212ºF (100ºC), the cleaning cycle should not exceed 2 hours duration and the temperature should not exceed 212ºF (100ºC).
- 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 NK 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. MERSEN USA can only make recommendations regarding the compatibility of the solvent with the graphite impregnation and not 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. Beware that Graphilor® graphite is attacked by strong oxidizing agents. These must be avoided.

d. Mechanical Cleaning

It is necessary to dismantle the NK exchanger unit in order to effectively clean both process and service side passages mechanically. Dismantling and re-assembly will be explained in the following sections of this manual. Several techniques can be used to clean the exchanger block. Precautions must be taken to avoid damage to the graphite components.

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

ii) Drilling
This method consists of drilling each hole with a slightly smaller diameter drill than the diameter of the holes. THIS METHOD IS VERY RISKY AND REQUIRES A VERY PRECISE DRILL. This should not be performed with a hand drill. If the drill is not aligned correctly, one can drill through the channel into the opposing perpendicular one, thus causing a cross leak.

iii) Brushing (or Brush Drilling)
This is the recommended method. The channels 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.

iv) 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, it is suggested that, after cleaning, the block be leak tested, prior to re-assembly of the unit.

Core block testing

The block can be tested without completely reassembling the exchanger. This test is performed using only the top and bottom clamping plates and the service heads.

The top and bottom clamping plates are assembled normally.

The service heads are installed on the block with long tie-rods to replace the process heads. This will allow the inspection of the process holes while the service side is under pressure.

The procedure is the same as described in section 2 except that the process holes are visible for inspection.

A hydrostatic test is still required on the completely assembled unit. The head gaskets must be tested.

e. Disassembly of the NK heat exchanger

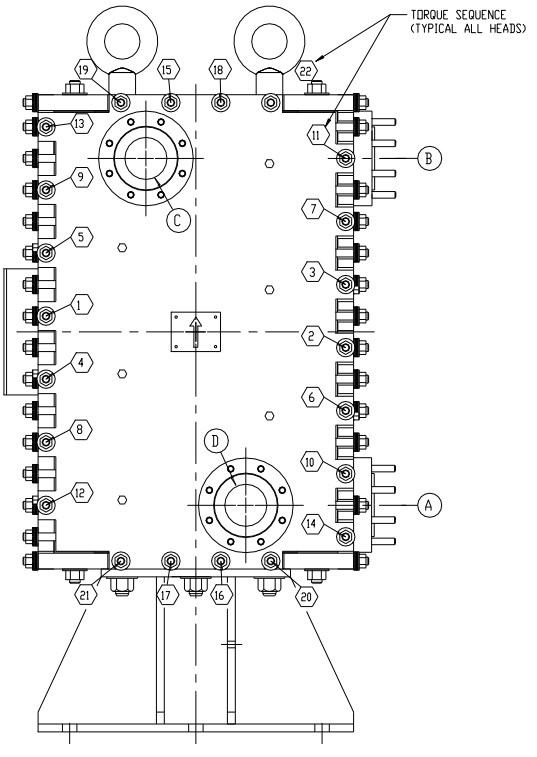
The exchanger must be in a vertical position with appropriate lifting equipment overhead. Single heads and/or the complete exchanger assembly should only be handled by the lifting lugs. If piping permits it, chemically clean and rinse the unit prior to disassembly. Disconnect all piping from the exchanger and drain it completely.

Put some solid wood blocks or hydraulic jacks under each head (service and process) to guarantee that they won't slip while the nuts are being loosened.

A crew of up to four (4) men (depending on the size and weight of the exchanger and its components) is recommended to loosen the nuts (a minimum of two (2) men are required) equipped with calibrated torque wrenches'.

Each fastener location on the exchanger is represented and numbered on the assembly drawing of the exchanger. They should also be identified on the exchanger as well. A permanent marker pen can be used to write directly on the heads. The numbering of the nuts is identical on opposing heads but can be different from service to process. Always refer to the assembly drawing for proper numbering. The numbering is important for torque sequencing of the fasteners.

The loosening of the nuts proceeds from the highest nut number towards nut number one, alternating between service and process heads.



TYPICAL FASTENER
IDENTIFICATION FOR CUBIC EXCHANGER

FIGURE 4

The loosening must be carried out simultaneously by all crewmen. For a team of two, they must alternate from process heads to service heads for each successive nut but each workman must always work on opposing heads.

Loosening should be carried with maximum 30 ft-lbs (40 N-m) increments.

Once all the nuts are close to being all loose, the heads can be prepared to be removed .

Make sure that every head is properly supported as mentioned before. A few nuts should be left in place in the top section to keep the heads from falling. (Note: Process and service heads are attached to each other.)

The heads should be laid on wood pieces to avoid any scratching and damage. Special attention should be given to the graphite liners. Graphite liners are brittle and can easily be cracked. No sharp objects should be put in contact with the graphite liners. Scratches on the gasket surface will create a leak path.

f. Assembly of the NK exchanger

Before proceeding with the assembly, the exchanger should be cleaned as described before.

Always use a new set of gaskets.

i) Installing new gaskets

Remove every piece of used gasket from the heads and the core block. Be very careful not to scratch the graphite while removing used gaskets. Acetone can help in removing gaskets and glue residues.

Once every gasket surface is clean, cut the required length of PTFE braid gasket for each head being reassembled. Lay down the gaskets on a clean piece of cardboard. Gaskets should be cut a few inches longer than required.

The gasket must be joined as shown on figure 5. One end can be prepared as shown on figure 5 on the cardboard while the other end should be done only once the gasket is in being placed on the head.

Apply a thin coat of gasket glue (contact cement or industrial silicone or other not detrimental to the process or service streams) to one face of the gasket and on the gasket surface of the heads to be reassembled. Wait until the glue is tacky. Never let the glue dry solid before assembly. If for some reason, this should happen, clean the gasket surface of the head with acetone and cut a new length of PTFE braid gasket and repeat the application of glue.

The glue must be applied uniformly in order to avoid build-ups that will cause uneven compression of the gasket.

The gasket can be put in place once the glue is tacky to finger touch on both the gasket and the head.

The gasket must be glued to the head and never on the block.

Start placing the gasket at the center of the top section of the head.

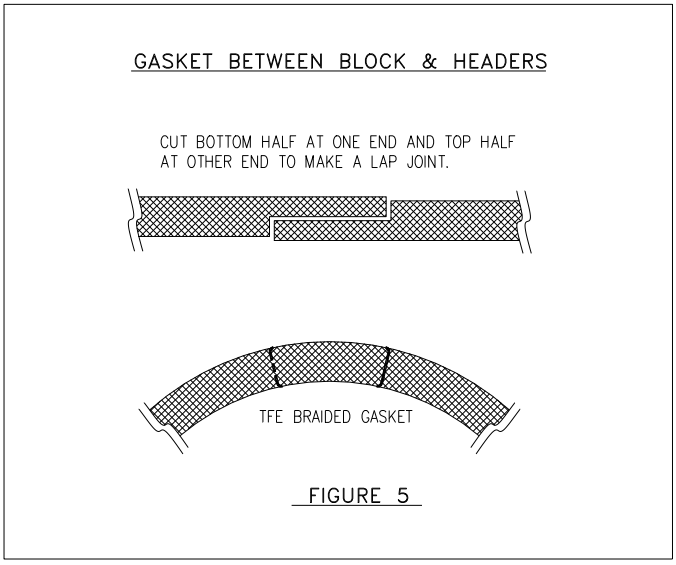


FIGURE 5

The gasket must be placed close to the inner edge of the gasket surface of the head and on the gasket grooves if any. Some exchangers require two strips of gaskets. Always refer to the assembly drawing for details.

Special care is required at corners to make sure the gasket does not slip too much inside the head.

Multi-pass heads will require an expanded PTFE strip (Goretex® or other) on the baffle ridges. A ¼" space should be left between the expanded PTFE strip and the head gasket, at both ends of the PTFE strip to allow for full drainage of the exchanger at shut-downs.

ii) Installing the heads

Install all the studs in the top clamping plate. Make sure to install it in the proper position; that is "up" facing "up". Each head should be marked to indicate the top or "up". Heads are not necessarily reversible.

Put the head in position on the block. The studs of the top clamping plate will serve as a guide. The head must be properly supported at all times. The weight of the head must not be supported by the studs. It is strongly recommended to put wood blocks or mechanical jacks to support the head in place. Install the nuts and spring washers on the top studs as soon as possible to prevent the head from falling.

The head must not be moved on the surface of the block once it is installed since this would disturb the gasket position and could create a leak.

Repeat this operation for each head.

Once the heads are in place, securely supported and attached to the top clamping plate, install all the other studs and spring washers on the heads and hand tighten the nuts to the studs. Studs should always be clean and anti-seize paste should be used to facilitate installation and future disassembly.

iii) Torqueing

Each nut is identified and numbered on the assembly drawing. This numbering system represents the torqueing sequence.

The nuts should be identified on the exchanger with a marker pen to facilitate torqueing. Opposing heads (process/process or service/service) have the same numbering but could be different from process to service. Always refer to the assembly drawing.

A crew of up to four men (depending on the size and weight of the exchanger and the heads) is recommended to torque the exchanger. A minimum crew of two men is required.

Torqueing has to be done simultaneously by all crew men and by following the torqueing sequence. Torque increments of 40 N-m (30 ft-lbs) are recommended until the torque specified on the assembly drawing is reached. The specified torque can be different on the process heads than on the service heads.

For a two men crew, torqueing must alternate from process to service.

g. Testing of the NK exchanger

i) Units should always be tested in a vertical position. Connect a heat source (hot water or low pressure steam) to the service nozzles.

ii) Low pressure steam (generally below 15 psig, 100 kPag) or hot water between 200ºF and 212ºF (95ºC to 100ºC) should be introduced gradually to the service nozzles and allowed to flow through the unit for at least two hours. Vent the unit as required. This should be continued until the entire unit is hot over 200ºF (95ºC). This procedure softens the seals and gaskets, allowing them to seat between the graphite blocks. Abrupt temperature changes must be avoided.

iii) The unit should be allowed to stand, preferably overnight, until it cools to approximately 100ºF (40ºC). Once the unit has cooled, retighten the nuts to the torque values shown on the assembly drawing all as per the previous section.

iv) One can now perform a service side hydro test as per the following instructions (refer to figure 2, page 2).

- Rig and support the unit in a vertical position (if not already done).
- Connect pressure piping & valving to the service nozzles in accordance with the applicable codes and standards for the test pressure to be used.
- Put a clean and dry piece of cardboard all around the exchanger, under the head gaskets to act as a leak detector.
- Fill the service circuits with water through the service connections.
- 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. Expect 2 to 10 psi (14 to 70 kPa) pressure drop over time dependant on test apparatus. Perform an initial hydro test by following these steps : (refer to figure 2). If a large leak develops, this will show as water fills the bottom of the process side up to the nozzle level. For a very small leak it would take too long to fill the bottom of the exchanger. In any case, it is possible to monitor the rate of the pressure drop on the process side. A decreasing rate would indicate compressing trapped air. Another way is to monitor the amount of water required to maintain the test pressure. Once again, a decreasing water flow indicates compressing entrapped air.

  TEST PRESSURE MUST NEVER EXCEED THE DESIGN OR TEST PRESSURE AS MARKED ON THE NAMEPLATE OR ON THE ASSEMBLY DRAWING <u>FOR BOTH SIDES</u> (process & service sides are independent).

v) If any leaks develop, the heating and cooling cycle should be repeated, perhaps with a higher temperature source (up to 250ºF (120ºC)) and proper torques. Any leaks that cannot be stopped in this manner indicate improper seating of the head gaskets or a leaking block. If this is the case, the unit must be disassembled to check for the source of the leak and then reassembled.

If no leaks develop, the unit is ready for installation in the process.

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. This may be difficult if there is no specific drain for horizontal arrangements. The unit may have to be lifted and turned on its side to allow full drainage through a down facing nozzle.

6. 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 (with suffix) from this drawing. 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 MERSEN USA representative, or the factories direct at:

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

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

Generic recommended spare parts list

TFE head gaskets
Expanded TFE rib baffle gasket
Nozzle inserts for graphite liner
Graphite liner for process header
Steel process header plate
Set of spring washers (Bellevilles)

7. CLEANING MERSEN EQUIPMENT BEFORE RETURNING IT TO MERSEN FOR REPAIRS.

Employee safety and the strict adherence to OSHA, EPA and other safety and pure air and water regulations are primary concerns to MERSEN USA. 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 MERSEN USA 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 MERSEN USA. 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 MERSEN USA. They should be disposed of in a manner consistent with the customer's safety or salvage policies.

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

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

8. STORAGE AND PRESERVATION REQUIREMENTS

MERSEN USA heat exchangers are protected against the elements during shipment. If they cannot be installed and put into operation immediately upon receipt, certain precautions are necessary to prevent deterioration during storage. Responsibility for integrity of the heat exchangers must be assumed by the user. MERSEN USA shall not be responsible for damage, corrosion or other deterioration of heat exchanger equipment during transit and storage. Good storage practices are important, considering the high costs of repair or replacement, and the possible delays for items which require long lead times for manufacture. The following suggested practices are provided solely as a convenience to the user, who shall make his own decision on whether to use all or any of them.

1. On receipt of the heat exchanger, inspect for shipping damage to all protective covers. If damage is evident, inspect for possible contamination and replace protective covers as required. If damage is extensive, notify the carrier immediately.

2. If the heat exchanger is not to be placed in immediate service, take precautions to prevent rusting or contamination. Heat exchangers are prone to 'breathing' due to thermal expansion/contraction. If the expectation is to store the equipment for more than 6 months, MERSEN USA recommends to blank off the exchanger nozzles and put a nitrogen blanket, 3-5 psi, on the service side of the heat exchanger. This would be in addition to including glycol.

   2.1. There are safety concerns when using gaseous nitrogen. When charging or discharging the gaseous nitrogen into or out of the heat exchanger, make sure you are in a well ventilated area.

3. Store under cover in a heated area, if possible. The ideal storage environment for heat exchangers and accessories is indoors, above grade, in a dry, low-humidity atmosphere which is sealed to prevent entry of blowing dust, rain or snow. Maintain temperatures between 70°F and 105°F (wide temperature swings may cause condensation and “sweating” of steel parts). Cover windows to prevent temperature variations caused by sunlight. Provide thermometers and humidity indicators at several points, and maintain atmosphere at 40% relative humidity or lower.

4. The end user should make every effort to store and/or preserve their graphite heat exchangers as mentioned in item # 3 above. However, if this cannot be accomplished and circumstances require storage in “freezing” conditions, special care shall be taken to protect the unit from exposure (i.e. covered with tarp or plastic sheets, crated, etc…). Depending on size and volume, MERSEN USA ships all heat exchangers with 3 – 5 gallons of glycol in each side of the equipment to keep residual water from freezing during transport. Upon receipt, the end user shall assume the responsibility to assure that the glycol is present and take the steps necessary to prevent future possibilities of freezing.

5. Remove any accumulations of dirt, water, ice or snow and wipe dry before moving exchangers into indoor storage. If unit was not filled with a preservative/Glycol and/or under a gaseous nitrogen blanket, open drain plugs to remove any accumulated moisture, then reseal. Accumulation of moisture usually indicates rusting has already started and remedial action should be taken.

   5.1. If the equipment is to remain in storage and there is a possibility that it will be exposed to freezing conditions, the end user is encouraged to replace the glycol in both sides of the heat exchanger.

6. Prior to installation of stored heat exchangers and accessories, including PTFE lined products, the end user shall assume the responsibility to assure that ALL torque settings (including verification of gasket torque values) are in accordance with applicable MERSEN USA drawings and installation manuals.

8. ASSEMBLY DRAWINGS (attached) & NOTES