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Tubular Heat Exchangers

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1.0 SHELL AND TUBE HEAT EXCHANGER INSTALLATION AND OPERATING MANUAL

A. Introduction

Flo Fab shell and tube heat exchangers are designed to facilitate heat transfer between two media of different temperatures without allowing them to mix while providing rugged construction for higher temperatures and pressures.

B. Construction

1. The shell and tube heat exchanger consist of two sides for the two different media. The **Tube Side** media flows inside the tubes and is diverted by the heat exchanger head located on the end into two or four passes or circuits. The **Shell Side** fluid flows on the outside of the tubes and is contained by the shell and diverted by baffles that also support the weight of the tubes. The wall of the tubes is the heat transfer surface.
2. All tubes are U-tube construction so when operating temperatures can cause a difference in linear expansion between the tubes and shell there is no risk of damage and the heat exchanger lasts many cycles.
3. All units are built to ASME Section VIII. CRN's are available. **T**ema class C is available upon request.

C. Installation

1. Before installing visually check all openings in the exchanger for debris.
2. Heat exchangers shall be mounted horizontally and square unless for steam service units which should have a 3° decline towards the shell outlet to facilitate the drainage of the condensate.
3. The heat exchanger shall be mounted in a location with allowance for **tube bundle removal space** at the head end of the heat exchanger. A tube bundle is the assembly of all the tubes held together by the tube sheet flat plate on the end and the baffles.
4. Provisions for isolating the heat exchanger with valves and bypass should be used for future inspection and repair of the heat exchanger.
5. Provide thermometer wells and pressure gauge connections in all piping to heat exchanger as close to exchanger as possible.
6. To prevent binding of system provide necessary air vents so trapped gas may be purged.
7. Use a vacuum breaker in the system to minimize water hammer.
8. Heat exchanger must be mounted so it will not cause loads on the piping.
9. Allow one end of heat exchanger to be mounted loose to allow thermal expansion of shell.
10. To prevent plugging of heat exchanger during start up make sure entire system is clean prior to putting in service. Use a strainer in the pipe leading to the exchanger if possible.
11. Do not pipe drain connections to a common closed manifold.
12. A gauge glass can be installed on the steam side to indicate flooding of exchanger and a faulty condensate trap.
13. Water hammer that can damage the exchanger can be caused by quick acting valves so care should be taken when selecting control system.

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D. Operation

1. When **starting up** open the vent and circulate the cold fluid first. Be sure the side is completely full and close the vent. Next vent the hot fluid side until completely full of liquid or water vapor and close vent. With all vents closed slowly bring heat exchanger up to operating temperatures.
2. During transit the tightening bolts may have loosened. Retighten bolts after installation and after heating up to prevent leaks and blowouts of gaskets.
3. Do not operate equipment under pressures and temperatures exceeding those indicated on the nameplate.
4. When **shutting down** the hot fluid should always be turned off first. Drain all fluids completely to avoid freezing and corrosion. Removal of water can be helped by blowing out with compressed air.

E. Problem Solving

1. If **Water Hammer** occurs in the heat exchanger the thin metal tubes can be damaged by impingement of the condensate and lead to failure. This applies to steam heaters only. Water hammer occurs when the heating load drops and the steam pressure in the exchanger drops so there is little or no pressure difference for the condensate trap to operate. The draining process stalls and the exchanger can flood with cooler condensate covering some or even all of the tubes. Now instead of condensing on the heat transfer surface the water vapor condenses earlier and is sent at high velocity to impinge against the tubes. To prevent water hammer;
    A. Make sure steam trap is sized for the worst case differential pressure which is more likely than the normal operating pressure when a modulating control valve is used.
    B. Properly sized condensate line.
    C. Under low load a vacuum can be created in the heat exchanger resulting in none or poor drainage of exchanger. Install a vacuum breaker to allow air in to the exchanger to break the vacuum.
    D. The exchanger must be installed at proper elevation so condensate flows downhill all the time.
    E. Quick closing control valves or a pump that stops can cause a sudden reversal of flow in the piping and cause hammer.
2. When water is being heated over 100°F and especially when the local water supply is considered hard; **scaling** can occur on the tubes. Scaling is built up on the tube wall when the water has high concentrations of calcium, carbonate and/or sulphates. The buildup can be so substantial that the exchanger tubes can be completely plugged. The situation can normally be recognized by seeing higher than normal pressure drops or a reduction in the water heating capability. To prevent or correct scaling;
    A. Use a water softener ahead of the water inlet to the heat exchanger.

B. Determine a regular maintenance schedule if scaling is a continuous problem to avoid outages.
C. Scale build up can be removed by chemically cleaning in place that does not require disassembly of the exchanger. Use the appropriate chemical cleaner that will not harm the materials of construction of the exchanger.
D. Tubes can be mechanically scraped and cleaned with care taken not to damage the softer metal heat transfer tubes.

F. Servicing

Nominal Bolt Diameter	Std Machine Bolts A-307 Torque Ft/lbs	High Tensile Bolts A-326 or A193-B7 Torque Ft/lbs
1/2	15	40
5/8	30	75
3/4	50	125
7/8	80	200
1	125	310
1-1/8	200	450
1-1/4	276	650
1-3/8		850
1-1/2		1000

1. Inspect the interior and the exterior of the tubes at regular intervals and keep them clean so unit operates at or near specified capacity.
2. When removing tube bundles from exchanger for cleaning, care should be taken to insure that improper handling does not damage them. The tube bundle should never be supported by the tubes but rested on the baffles or tube sheet.
3. Horizontal tube bundles should be lifted by means of suitable slings around the baffles and/or tube sheet. Do not lift bundle with hooks or other devices which could damage the tubes.
4. Loose tube joints can be rerolled tightened using a roller type expander. Do not roll tubes that are not leaking as this thins the tube and work hardens the material leading to earlier failure. Avoid over rolling the tubes as this could also lead to damaging the tube sheet.
5. **Replacing Gaskets**: Gaskets and gasket faces should be thoroughly clean and should be free of scratches and other defects. Accurately position the gaskets before retightening the bolts. Wessels recommends using new gaskets whenever an exchanger is dismantled and re assembled.
6. **Bolting**: Tighten all bolts uniformly and in a diametrically staggered pattern applying torques per the following table;

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G. Spare and replacement parts

1. Contact the Flo Fab Company for proper replacement parts.