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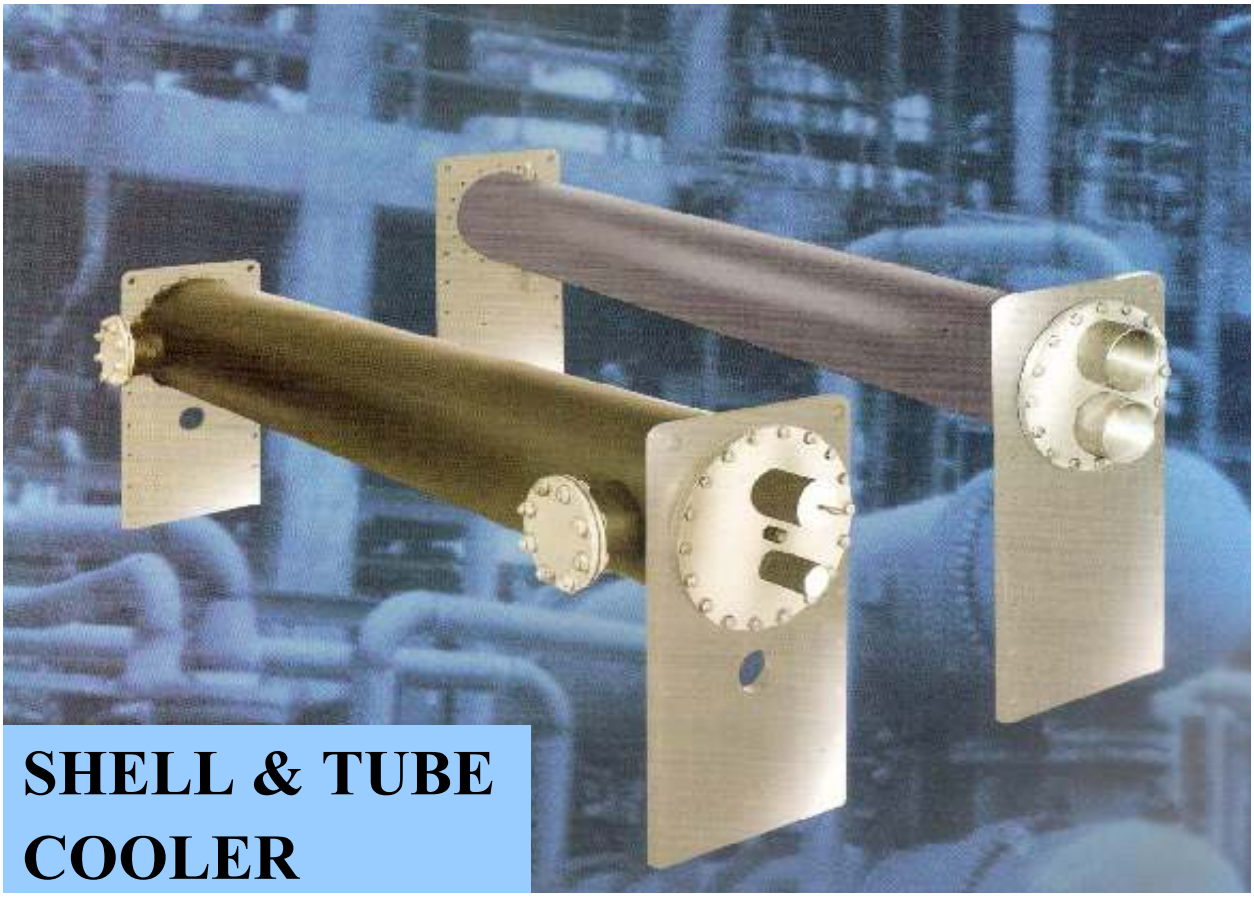

SHELL & TUBE COOLER

DOSH Certified Manufacturer- BT21/456

INSTALLATION, UTILIZATION & MAINTENANCE MANUAL

This manual refers to HTT series of evaporator.

The units are designed in accordance with the pressure and temperature limits according to the design approval.

Refrigerant side: The series has been designed for use with HCFC and HFC refrigerants.

Water side: The fluid used is generally water in a closed circuit.
The application may feature the use of water with the addition of antifreeze fluid, for example ethylene or propylene glycol.

1. INSTALLATION

This unit must be installed only by qualified personnel.

1.1 Receipt and Inspection of the Product

Check that the exchanger corresponds to the type ordered. Check that all the components have been delivered and that they have not been damaged during transport. In the event of damage to the units or missing components, a written claim must be sent to the carrier.

1.2 Storing the Product

Before installation, the evaporator must be stored in a dry, sheltered place. Avoid sites where condensate may form inside the exchanger, due to temperature variations during the day (for example, exposure to sunlight)

1.3 Positioning the Exchanger

The units can be handled using the elastic hoisting straps position at the sides of the exchanger. The units must be installed horizontally, and fastened to supports, brackets or longitudinal members. Non-horizontal installation may considerably affect performance. The exchanger must be positioned in such a way as to allow any inspection, maintenance and replacement operations to be carried out comfortably.

1.4 Refrigerant Connection

The refrigerant connections are located on the head of the exchanger; the inlet (liquid line) is on the lower part of the head. Standard connections are welded pipes, flanges connections also available on request.

1.5 Water Side Connection

The type of connection for the unit is flanged connections with the same nominal diameter as the standard versions. Upon request, flexible fitting/ Victaulic are available.

No welding may be performed near the joints, as the seal may be damaged by the high welding temperatures.

1.6 Insulation

The insulation supplied is light weight elastomeric nitrile foam material designed for thermal insulation. The closed cell structure provides an efficient vapour barrier for the prevention of condensation or frost formation on cooling systems, chilled water & refrigeration line.

The nominal thickness is ¾", while others thicknesses are available upon requested.

2. GENERAL INSTRUCTION FOR CORRECT OPERATION

The operating pressure and temperature on the refrigerant side and water side of the system must comply with the maximum values shown on the evaporator's rating plate.

2.1 Analysis of Hazards for the Operator

- **Pressure**. The evaporators are pressurized containers, and as such are governed by the national standards relating to these appliances. The evaporators have been designed and manufactured in compliance with the reference standards. The operator must therefore observe all the active and passive safety requirements defined by the standards.
- **Temperature.** The evaporators are designed to operate with temperatures (both on the refrigerant side and water side) no higher than 90°C (average wall temperature).
- **Refrigerant.** The evaporators are designed for operation. These fluids are not toxic, harmful or explosive; however require the observance of normal precautions. In particular, in the case of refrigerating systems in which the refrigerant is pre-charged, all the environmental conditions that may lead to an abnormal increase in pressure must be envisaged and the operation of the safety devices must not be disabled. Make sure that the setting of the safety valve is not higher than the design pressure specified on the exchanger rating plate.
- **Water.** Water with the addition of some antifreeze fluids may be toxic.

2.2 SAFETY SYSTEM

Below are a number of recommendations that must be observed during the installation, start-up and maintenance of the system. Make sure that the safety devices have been installed in the system and that prevent the unit from being damaged.

- **Freezing**. In the event of operation with average evaporation temperatures below 0°C, make sure a correct antifreeze mixture (brine) is used. The same precaution must be followed in the case of installations outdoors or in environments where the temperature may fall below zero, even for brief periods. The use not provides an absolute guarantee for all operating conditions, such as sudden drops in temperature or power failures. To avoid falling below the freezing point of the type of fluid used (water or brine), the antifreeze thermostat must be suitably set, so that the minimum temperature, determined by the average between the brine outlet temperature and the evaporation temperature, is 1K higher than the freezing point. On the refrigerant side, a minimum pressure switch is required; if the pump-down function is featured, also a timer should be installed to prevent extended pressure and temperature drops. In the case of extended inactivity of the system, drain the water from the shell through the drain connection located at the bottom of the shell.
- **External particles on the water side**. Filter must be fitted on the water side, in the pump intake line, to prevent particles such as welding residues and solid particles in general from entering the shell side and damaging the tubes of the exchanger.

2.3 WATER QUALITY AND TREATMENT

Only some applications require the use of completely clean water. In general, the water used derives from closed systems (mains water), or in some cases from open systems, such as; ground / well water, river or lake water. This water may over time over give rise to the precipitation and deposit of organic and inorganic substances on the outside of the tubes.

Such deposits are commonly called fouling. Fouling offers thermal resistance, inhibiting the heat exchange between the fluids, and hydraulic resistance, increasing pressure drops.

Below are some of the some of the more common cases of fouling in applications with shell & tube evaporators.

- **Deposits.** These phenomena are related to the precipitation of inorganic salts; the more common of these are calcium carbonates $CaCO_3$, which are however are easily soluble in acidic solvents, and calcium sulphates $CaCO_4$, which are on the other hand less readily soluble. This type of fouling is also known as scaling, and generally occurs when the temperature on the wall of the tubes is above 45°C; in addition, it depends on the quality of the water used in the open systems.

- **Algae.** This phenomenon is typical of lake or river water. In this case, simply install a filter in the tubes to prevent the algae from reaching the inside of the evaporator. As well as a reduction in thermal performance, algae deposits may also cause corrosion on the outside of the tubes.
- **Bacteria.** Bacteria may grow anywhere, if the conditions are suitable, but cannot be trapped by filters or sieves. Bacteria may develop and grow in the presence of sulphur-, nitrogen- or phosphorus-based compounds. In this case too, the deposit of bacterial flora affects heat exchange and may be the cause of corrosion.

  Preventing the action of bacteria is not easy, as even "clean" water may over time give rise to the formation of bacterial flora. To prevent this phenomenon, continuous checks must be made on all the components in the water circuit.

Prevention and Cleaning Methods

Water in closed circuits can be treated, while well, mains or river water does not normally require treatment. In this case, we always recommend the installation of a filter upstream of the evaporator. It is the user's responsibility to establish the quality of the water and make sure that this is compatible with the materials used in the exchanger. The quality of the water, for the reasons described above, may significantly influence the operation and the life of the exchanger. The first step in planning the treatment of the water is chemical analysis, which must be performed by qualified personnel from specialist organizations.

Some of the parameters that must be measured are:

- The hardness of the water, to evaluate the need for softening.
- Analysis of the pH, to define the need for chemical treatment in the event of excessively acidic or excessively alkaline water: the pH value must be between 7.5 and 9.
- Analysis of the sediments, to determine the need for filters in order to prevent the formation and accumulation of residuals and the erosion of the tubes.

Fouling Water

Generally one the following indices are used to check if the water used may lead to fouling. These indices provide indications on the behavior of the water: they not therefore be considered as absolute references.

Langelier index

L.I. = pH-pS-pAlc-pCa

>0	Tendency to cause scaling
=0	Stable
0	Tendency to cause corrosion

Ryznar stability index

R.S.I. = 2 x (pS-pAlc-pCa) – pH

= 4-5	Tendencies to cause scaling
= 6-7	Stable
= 8-9	Tendency to cause corrosion

The corrosive action mainly affects carbon steel & has less effect on materials made from copper and copper alloys.

These evaluations must always be made by personnel from companies specializing in water treatment.

The cleaning of the outside of the tube bundles must only be performed using chemical methods. Cleaning is performed by recirculation to the type of fouling, organic or inorganic: a recommended product is P3 T288 by Henkel. This operation must be performed only by qualified personnel.

Water with a High Organic Content (Algae, Bacteria)

In this case, only chemical methods can be used. Special algicide and bactericide solutions are available on the market.

2.4 CORROSION

The oxygen dissolved in water increases the rate of corrosion. The main factors causing corrosion are sulphur and carbon dioxide acids. See the Langelier and Ryznar indices. A combined effect of fouling due to dust and organic material provides a support for bacteria, fungi and algae; the growth of these organisms may produce an oxygen gradient and this result in rather severe pitting of the surface of the metal.

The phenomenon of corrosion is obviously related to the materials used on the liquid side of the heat exchanger.

Water component for corrosion limit on Copper

pH	7.5 ~ 9.0	
SO_4^-	< 100	ppm
HCO_3^-/ SO_4^-	> 1.0	
Total Hardness	4.5 ~ 8.5	dH
Cl-	< 50	ppm
PO_4^{3-}	< 2.0	ppm
NH3	< 0.5	ppm
Free Chlorine	< 0.5	ppm
Fe^{3+}	< 0.5	ppm
Mn^{++}	< 0.05	ppm
CO_2	< 50	ppm
H_2S	< 50	ppm
Temperature	< 65	°C
Oxygen Content	< 0.1	ppm

2.5 USE OF BRINE

Brine fluids, such as ethylene or propylene glycol are generally not corrosive if suitable inhibitors are added. Minor effects on carbon steel may occur if $CaCl_2$ is used.

Neutral brine is relatively non-corrosive, even it is corrosion potential may be affected by various forms of combination. Avoid the excessive aeration of brine and used closed systems. The brine must be inhibited and the pH maintained. The brine should be tested periodically to check the effectiveness of the inhibitors.

2.6 VIBRATION

Excessive vibrations on both the water side and refrigerant side may cause significant damage to the exchanger over time. To reduce the transmission of vibration dampers on the water side, install vibration dampers near the water connections, on the supports and on the structure. In this case where the exchanger is installed as a support element for the compressor, measures must be taken to avoid the transmission of vibration to the exchanger.

Normally the vibration rate of the heat exchanger cannot exceed 0.1m/sec.

2.7 WATER FLOW RATES

Never exceed the maximum water flow rate limits: high flow rates may cause serious damage to the exchanger. In the case of parallel connections to other refrigerating units or systems with complex loop cycles, consider the maximum flow rate values.

2.8 MALFUNCTION / PERFORMANCE

Below are some suggestions to avoid the incorrect operation of the exchanger.

Thermostatic Valve

Between the thermostatic valve and the refrigerant inlet connection, install a straight section of tubing around 8-10 times longer than its diameter. The presence of any curves may affect the performance of the exchanger.

If the valve supplied is with less liquid refrigerant, it may reach unstable conditions, with continuous fluctuations: this valve behavior negatively affects the performance of the exchanger.

Excessive Overheating

Excessive overheating significantly affects the performance of the exchanger; the superheating values should be between 4 - 6K.

3. STARTING THE UNIT

The system must be started by qualified personnel. Make sure that all the instructions given in the previous chapters have been observed. Before starting the system, make sure the absorbent fillers placed inside the refrigerant circuit, at the outlet connection, have been removed.

When filling the exchanger with water, make sure the air is vented through the service connection on the bottom at the rear, or through the water connections. Careful attention must be paid when starting the system to ensure that there is no air inside the exchanger: the presence of air bubbles in the water may damage the tubes.

In the case of water connections to open circuits (well, external tanks), prevent air from entering the exchanger when the pumps are off: the presence of air will cause corrosion and damage the exchanger. The layout of the water piping must be designed so as to avoid the down flow of water from the exchanger, and consequently the inlet of air when the pumps are off.

4. MAINTENANCE

For the optimum maintenance of the exchanger components, periodical checks should be carried out by qualified personnel. The necessity and frequency of such checks depends on the performance of exchanger over time.

Check	Recommended Frequency
Evaporator head screw tightening torque	3 years
Flanged refrigerant connection screw tightening torque	3 years
Check for refrigerant leaks from the seals on the head	3 years

With a torque wrench, check the tightness of screws, the value must correspond to below:

Screw Type (UNI)	Tightening Type	Torque Range
M12	Not Lubricate	120
M16	Not Lubricate	180

Refrigerant leaks from the seals on the head are normally checked using a “Leak Detector” or “Sniffer”.

5. WARRANTY CONDITIONS AND VALIDITY

HTT declines all liability for damage caused by incorrect commissioning of the product.

The general warranty conditions are no longer valid if the fault in the product is caused by the incorrect installation of the unit or evident negligence by the user.

Promptly contact HTT if defect are found during the warranty period, indicating the type of unit, the serial number & the defect found.

Warranty should be 18 months from factory invoice date or 12months from commissioning.

Cooler

Load	btu/hr	
Water entering temp	F	
Refrigerant	R22/ R134A/ R407C	
Water fouling factor	FTsq.F.hr/btu	
No of refrigerant circuit		
Shell design working pressure	psig	
Water flow	GPM	
Water leaving temp	F	
Evaporating tamp	F	
Max water pressure drop	ft	
Dimension limitation	mm	
Tube design working pressure	psig	

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