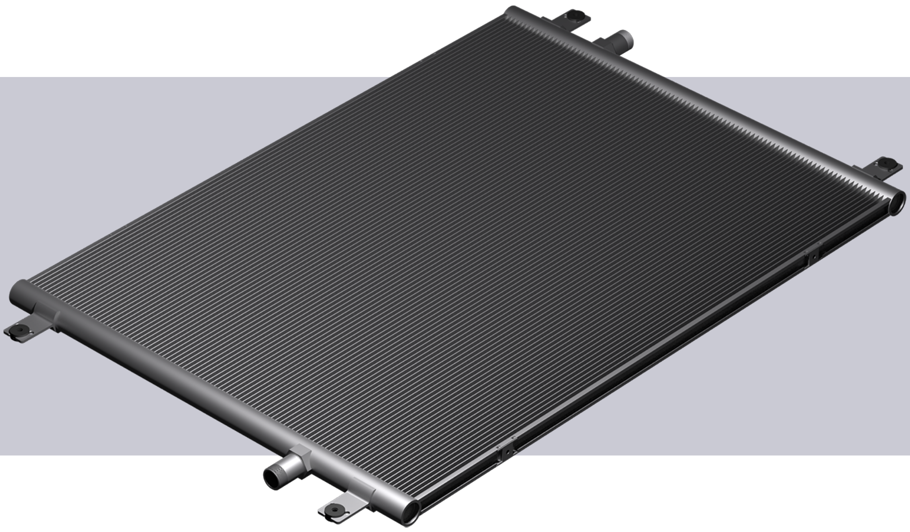
Microchannel Fluid Coils

HEAT EXCHANGERS FOR COOLING AND HEATING



- DESIGN AND SPECIFICATIONS
- INSTALLATION GUIDELINES
- MAINTENANCE

TECHNICAL MANUAL
ENGLISH

WATER GLYCOLS SPECIAL FLUIDS

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KALTRA

CUSTOMER SERVICES

Maintenance and Warranty

As standard, Kaltra guarantees heat exchangers for a period of 24 months uncoated and 60 months e-coated, variations tailored to suit product and application are also available; please contact Kaltra for full terms and details.
For a free quotation contact Kaltra or your local sales engineer. All Kaltra products are designed in accordance with European and international standards and norms.

⚠ **CAUTION**

Warranty cover is not a substitute for maintenance. Warranty cover is conditional to maintenance being carried out in accordance with the recommendations provided during the warranty period. Failure to have the maintenance procedures carried out will invalidate the warranty and any liabilities by Kaltra.

In addition to warranty services, a 24 hour, 7 days a week on-call service is available throughout the year to EU sites. This service will enable customers to contact a duty engineer outside normal working hours and receive assistance over the telephone or per email. The duty engineer can, if necessary, attend site. Full details will be forwarded on acceptance of the maintenance agreement.

Service Contacts

For further assistance, please e-mail: support@kaltra.de or telephone:

Sales enquiries:	+49 (0) 911 715 320 21	sales@kaltra.de
24/7 support hotline:	+49 (0) 151 418 586 90	support@kaltra.de
Information:	+49 (0) 089 943 998 66	info@kaltra.de
Delivery:	+49 (0) 911 715 320 21	delivery@kaltra.de
Spares:	+49 (0) 911 715 320 21	spares@kaltra.de

SAFETY

The information contained in this manual is critical to correct installation and maintenance of heat exchangers and should be read by all persons responsible for the procedures mentioned above.
Heat exchangers have been designed and manufactured to meet international safety standards, but care must be taken if you are to obtain the best results.

⚠ **CAUTION**

Installation and maintenance work on heat exchangers should be undertaken by competent and trained personnel in accordance with local relevant standards and codes of practice.
Improperly installed, adjusted or altered equipment by an unqualified person could result in death or severe injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

Personal Protective Equipment and Handling

Kaltra recommends that personal protective equipment is used while installing and servicing heat exchangers. Some operations, when servicing heat exchangers, may require additional assistance with regard to manual handling. This requirement is down to the discretion of the engineer. Remember, do not perform a lift that exceeds your ability.

IMPORTANT

All personnel being responsible for the operation, installation, and maintenance of heat exchangers must carefully read and fully understand these instructions before transportation, loading/unloading, handling, installing, and servicing heat exchangers.

CONTENT

INTRODUCTION

Purpose of Present Manual

The purpose of the present manual is to guide engineers through the selection process of microchannel fluid coils subject to application, operating and environmental requirements and conditions. The manual provides Kaltra customers with recommendations for coil installation, operating parameters, maintenance, and troubleshooting.

> **IMPORTANT**
> The development and improvement of Kaltra microchannel heat exchanger products are continuous, and the information in the present manual may not be up to date.
> Please check the current position with Kaltra.

Product Applications

Microchannel fluid coils are intended for use in closed-loop cooling and heating applications and designed for use with water, glycols, hydraulic and lube oils, gases, and special fluids that are compatible with aluminum. Typical applications include chilled water coils, free cooling coils, dry coolers, heating coils, pumped loop evaporators, gas cooling and heating, and coils for special purposes.

> **IMPORTANT**
> Prior to use, ensure the fluid used in application complies with the requirements listed in the present manual and compatible with aluminum.

Product Advantages

Compared to other types of air-to-fluid heat exchangers, microchannel coils present considerable advantages in performance and design:

- Better thermal performance. Heat transfer coefficients increase with decreasing in the hydraulic diameter of the tubes. The metallurgical bond achieved by brazing significantly reduces thermal resistance of the microchannel heat exchanger when compared to mechanically bonded heat exchangers
- Closer approach temperatures
- Improved airside performance with lower pressure drops
- Improved fluid side performance with reduced pressure drops
- Higher resistance against corrosion and other environmental influences
- Compact and robust design with low internal coil volume
- Reduced weight
- Easy and low-cost maintenance and easy recycling
- Optimized end-cost

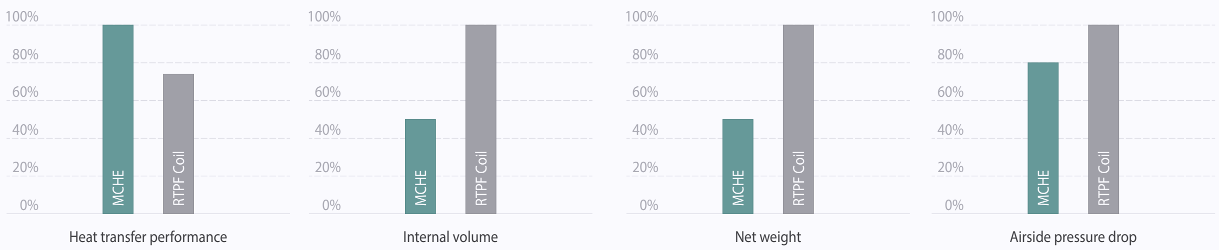


Fig. 1: Microchannel coils vs. finned tube coils

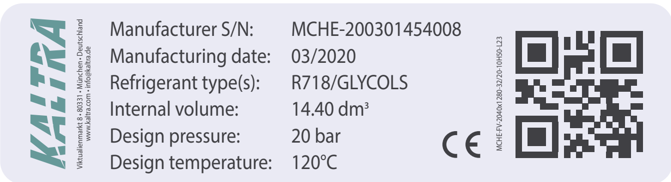
Kaltra uses strong long-life aluminum alloys (SLLAs) in the manufacturing of microchannel tubes. These alloys - specially developed for HVAC applications - demonstrate ultimate corrosion resistance not found in other products. We offer surface treatments like electrocoating and trivalent chromium process (TCP) coating to boost corrosion protection even for the use of our heat exchangers in marine atmosphere and highly-polluted environments. Performance, quality, and other characteristics of our heat exchangers are confirmed by appropriate certifications, laboratory tests, and proven in the field.

Product Labeling

The product label identifies the product and provides essential information about the product and its use, including design specification, internal coil volume, design pressure and temperature. The product label is affixed to one of the heat exchanger manifolds.

MCHE F V - 2040 x 1280 - 36 / 20 - 10 H 50 - L - 23

Application	F	Fluid coil	F
Tube arrangement	H V	Horizontal Vertical	V
Width		mm	2040
Height		mm	1280
Tube width		mm	36
Tube thickness		mm • 10	20
Ports		Number of tube ports	10
Manifold diameter		mm	H50
Type of fins	L F	Louvered Flat	L
Fin density		FPI	23



Operating Conditions

Microchannel heat exchanger operating conditions		
Outdoor air temperatures		
Minimum design temperature	°C	-40.0[1]
Maximum design temperature	°C	120.0[1]
Process fluid temperatures		
Maximum design temperature	°C	120.0
Process fluid pressures		
Design pressure	bar	20
Burst pressure	bar	50/70/100

[1] - for heat exchanger coils with e-coating: -40.0°C to 165.0°C; for heat exchanger coils with TCP-coating: -30.0°C to 150.0°C

IMPORTANT Design operating pressure value can be found on the product label.

Process Fluids

Microchannel coils are suitable for use with water, glycols - propylene glycol and ethylene glycol, special fluids like hydraulic or lube oils, and other liquids that are compatible with aluminum.

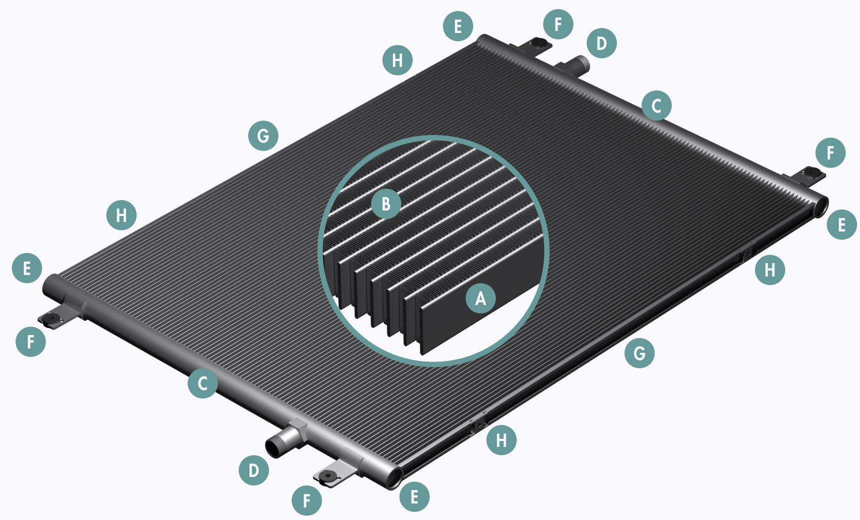
IMPORTANT Fluids allowed to use with your microchannel heat exchanger are specified on the product label and/or datasheets supplied with the product.

IMPORTANT Consult with Kaltra regarding the compatibility of specific liquid with your microchannel fluid coil.

HEAT EXCHANGER DESIGN

General Design

Microchannel coil is designed with the fluid inlet and outlet round tube manifolds and flat multiport tubes extending between them, and airside fins of louvered or flat design. Components of the coil are metallurgically bonded together using controlled-atmosphere brazing (CAB) furnace.
Depending on application requirements, design engineers may pick up the suitable flat-tube size and configuration, manifold diameter and wall thickness, type of airside fins, fluid connections, type and location of mountings.
Protective anti-corrosion surface coatings, epoxy electrophoretic or trivalent chromium types, as well as the zinc treatment of inner coil surface, are available optionally.



A Multiport tubes
B Airside fins
C Manifolds
D Fluid connections
E End caps
F Mounting brackets
G Reinforcement bars
H Side fixtures

Fig. 2: Microchannel fluid coil construction

Microchannel fluid coils can be manufactured with either horizontally- or vertically-oriented multiport tubes. In the former case, manifolds are located vertically, while in the second case, manifolds are of a horizontal layout (Fig. 3A, 3B). For some applications with vertical heat exchanger orientation or installations with steep inclination angles, a gravity-assisted vertical fluid flow layout is preferable over the horizontal design. For vertical tube layouts, the fluid inlet from the top manifold is preferential.

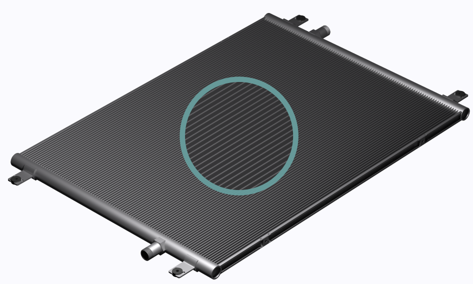


Fig. 3A: Fluid coil with horizontal tubes

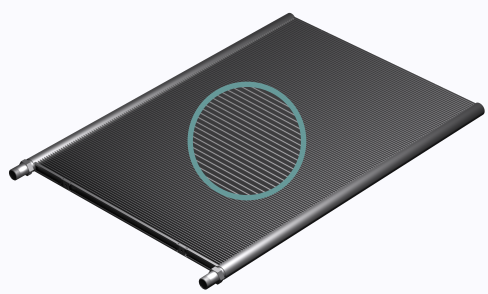


Fig. 3B: Fluid coil with vertical tubes

Kaltra offers microchannel fluid coils to order, with the length varying from 50mm to 6000mm and widths from 50mm to 2000mm, with different tube widths and manifolds diameters, fluid connections and mountings to customer specification. The following table summarizes possible heat exchanger configurations and properties:

DESIGN

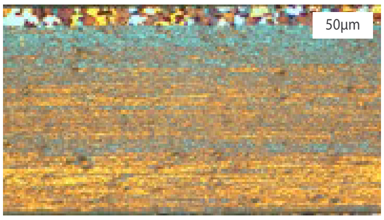
General specifications		
Property	Units	
Max length	mm	6000
Max width	mm	2000
Tube width	mm	16.0 / 18.8 / 20.0 / 22.0 / 25.4 / 32.0 / 36.0
Tube spacing	mm	8.1 / 9.4 / 10.0
Manifold diameters	mm	16 / 20 / 25 / 30 / 32 / 38 / 42 / 50
Fin types		FLAT / LOUVERED
Fin pitch	FPI	10 / 16 / 18 / 19 / 21 / 23 / 24 / BY REQUEST
Design pressure	bar	20
Burst pressure	bar	50/70/100
Process fluids		WATER / GLYCOLS / OILS / SPECIAL
Protective coatings		NONE / E-COATING / TCP-COATING

Materials

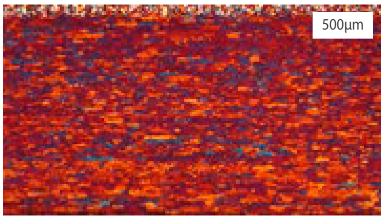
Material properties are crucial for heat exchanger durability and corrosion resistance, especially when it comes to operating in aggressive atmospheres like highly-polluted industrial and urban areas, coastal zones, and other corrosive environments.
To achieve the highest product performances, Kaltra uses aluminum alloys and clads of series 3xxx, 4xxx, 7xxx, as well as strong long-life alloys (SLLAs) of series 9xxx.

Aluminum alloys						
Part	Alloy/Temper	Clad alloy/Temper	Coating	Additions/Modifications		
				Mn	Zn	Si
Multiport extrusion tubes (MPE)	AA3102-H112	-	Zn (ZAS)	0.4%	0.0÷0.3%	0.0÷0.4%
Multiport extrusion tubes (MPE)	AA3103-H12	-	Zn (ZAS)	0.9÷1.5%	0.0÷0.2%	0.0÷0.5%
Multiport extrusion tubes (MPE)	3F03-H112	-	Zn (ZAS)	0.9÷1.1%	0.2÷0.5%	0.6÷1.5%
Multiport extrusion tubes (MPE)	HA9153A-H112	-	Zn (ZAS)	0.7÷1.2%	0.2÷0.5%	0.6÷1.5%
Manifold tubes	AA4045	AA3003-H14/AA3005-H14	-	0.0%	0.0÷0.1%	9.0÷11.0%
Fin foil	FA7971	AA4343-H14SR	-	1.0÷1.5%	1.3÷1.7%	0.6%

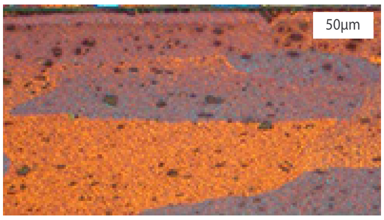
The manufacturing of microchannel heat exchangers is an industrial CAB process - stands for controlled atmosphere brazing. CAB process is a flux-aided furnace brazing process under an inert shielding gas (nitrogen). Flux is required to clean the surfaces of the aluminum parts from oxides. For its microchannel heat exchangers, Kaltra uses the latest generation fluxes designed to give corrosion protection by controlled zinc load in addition to providing fin-to-tube joint filler formation. The silicon particles in the coating form the joint by reacting with aluminum, therefore replacing the use of clad fin. Aluminum alloys coated such a way exhibit excellent corrosion properties due to the formation of dense band of precipitates.
Coatings provide additional protection against corrosion and abrasion for microchannel tubes. Zinc arc spray process, implicating the projection of atomized molten zinc onto the surface to create a protective zinc diffusion layer, is a principal method to achieve high corrosion protection used in the manufacturing of microchannel tubes used in Kaltra's heat exchangers.
Putting a zinc layer on top of an aluminum alloy protects the core of the tube by providing a preferred path for corrosion to spread. Zinc is a less noble element compared to aluminum alloys. Zinc acts as a sacrificial layer guiding corrosion along the surface of the tube instead of through the tube walls. This corrosion behavior will lengthen the lifetime of the tube. With zinc arc spraying, an even coating with a good metallic bond is formed on the tubes, and this zinc layer will diffuse into the microchannel tube core during brazing.



The dense band of precipitates (brown), formed during brazing of long-life alloys, is the key to producing the excellent corrosion performance compared with conventional alloys.



The composition of silicon and magnesium makes tube alloys easy to braze in the controlled atmosphere brazing process while showing good corrosion resistance after brazing.



Optimized aluminum alloy composition contributes to a high strength after brazing and provides sacrificial layer to improve the long-term corrosion resistance for microchannel tubes.

Microchannel Tubes

Heat exchangers can be configured and manufactured with flat microchannel tubes - also referred to as multiport extrusion (MPE) tubes - of different widths, geometry, port quantity, and port sizes, depending on customer requirements, fluid type, and performance demands. Standard or long-life aluminum alloys are the materials for microchannel tubes used in the manufacturing of Kaltra heat exchangers. High manganese-containing, zinc-coated long-life alloys exhibit excellent corrosion properties thanks to the formation of dense band of precipitates (DBP).

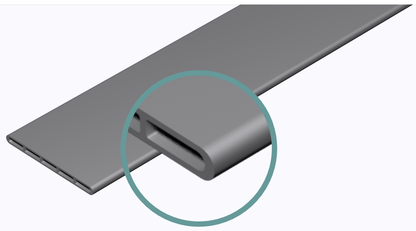


Fig. 4A: MPE tube with large ports

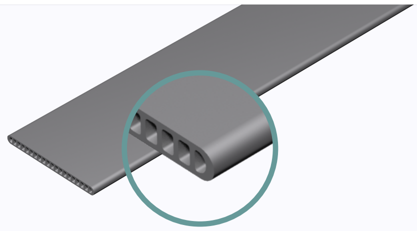


Fig. 4B: MPE tube with small ports

Microchannel tubes are fabricated using direct hot extrusion through hollow dies and characterized by specifically selected alloys and coatings, tolerances, which have been optimized for cooling applications. As standard, the following tubes with the widths from 16mm to 36mm are available for fluid coils:

Microchannel tube specifications - fluid coils

Sectional view	Code	Tube width	Tube thickness	Ports	Wall thickness	Applications
		mm	mm		mm	
	S16/17-15	16.0	1.7	15	0.30	GENERAL PURPOSE / UNIVERSAL
	S18/19-13	18.8	1.9	13	0.28	LOW PRESSURE / MEDIUM PRESSURE
	S20/20-10	20.0	2.0	10	0.35	LOW PRESSURE / MEDIUM PRESSURE
	H20/20-12	20.0	2.0	12	0.27	LOW PRESSURE / MEDIUM PRESSURE
	S20/20-12	20.0	2.0	12	0.40	GENERAL PURPOSE / UNIVERSAL
	S22/20-12	22.0	2.0	10	0.35	GENERAL PURPOSE / UNIVERSAL
	H25/20-20	25.4	2.0	20	0.32	HIGH PRESSURE / MEDIUM PRESSURE
	S25/20-05	25.4	2.0	5	0.40	LOW PRESSURE
	S25/20-15	25.4	2.0	15	0.27	GENERAL PURPOSE / UNIVERSAL
	H25/20-13	25.4	2.0	13	0.33	HIGH PRESSURE / MEDIUM PRESSURE
	S32/20-16	32.0	2.0	16	0.35	GENERAL PURPOSE / UNIVERSAL
	S36/20-10	36.0	2.0	10	0.36	LOW PRESSURE
	H36/20-26	36.0	2.0	26	0.33	HIGH PRESSURE / MEDIUM PRESSURE
	S36/20-16	36.0	2.0	16	0.36	GENERAL PURPOSE / UNIVERSAL

IMPORTANT

Microchannel tubes with higher wall thickness withstand corrosion better and recommended for installations in high-corrosive environments.

Airside Fins

Kaltra microchannel heat exchangers can be designed with either louvered or flat fins, depending on desired performance, application conditions and customer requirements. Louvered fins offer significantly higher heat transfer characteristics but also higher pressure drop on the airside, while heat exchangers with flat fins demonstrate better characteristics in some specific applications like operation in frosting conditions.

Flat Fins

Flat fins also advantageous for industrial applications as flat fin coils tend much less to airside fouling. Industrial fluid coolers generally operate with higher air-to-fluid temperature delta, and, if that is the case, the surface area of flat fins perfectly matches the application.

Louvered Fins

The louvered fins enhance the heat transfer by providing multiple flat-plate leading edges with their associated high values of heat transfer coefficient. Louvered fins enhance heat transfer by a factor of 2 to 3 compared with equivalent flat surfaces. The louvers have the further advantage that the enhancement of heat transfer is gained without a significant increase in flow resistance.
In louvered fins, fin height, louver angle, number of louvers, louver pitch and fin geometry as a whole are selected for an optimum balance of heat transfer and air resistance.

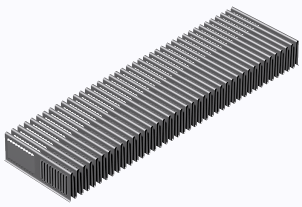


Fig. 5A: Louvered fins

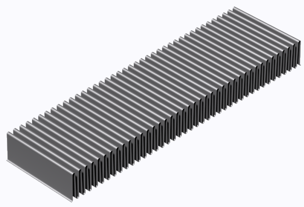
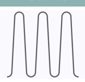


Fig. 5B: Flat fins

Heat exchangers can be manufactured with different fin pitches, from 10FPI to 24FPI, to suit desired performance, air resistance, and other requirements. Custom fin types and pitches are available on request. As standard, fin thickness is 0.08mm; fin height is 8.0 or 8.1mm; fin strip width matches microchannel tube width.

Fin specifications - fluid coils

Sectional view	Code	Fin height	Fin width	Gauge	Fin density
Louvered fins		mm	mm	mm	FPI
	L81/120	8.10	12.0	0.08	21.0 / 23.0
	L81/160	8.10	16.0	0.08	18.0 / 19.5 / 21.0 / 23.0
	L80/188	8.00	18.8	0.08	21.0 / 23.0
	L81/200	8.10	20.0	0.08	21.0 / 23.0
	L80/200	8.00	20.0	0.08	10.0 / 16.0 / 19.5 / 21.0 / 23.0 / 24.0
	L80/220	8.00	22.0	0.08	21.0 / 23.0
	L81/254	8.10	25.4	0.08	21.0 / 23.0
	L80/254	8.00	25.4	0.08	18.0 / 19.5 / 21.0 / 23.0
	L81/320	8.10	32.0	0.08	21.0 / 23.0
	L80/320	8.00	32.0	0.08	10.0 / 16.0 / 18.0 / 19.5 / 21.0 / 23.0 / 24.0
	L81/360	8.10	36.0	0.08	21.0 / 23.0
	L80/360	8.00	36.0	0.08	18.0 / 19.5 / 21.0 / 23.0
Flat fins		mm	mm	mm	FPI
	F80/200	8.00	20.0	0.10	10.0
	F80/320	8.00	32.0	0.10	10.0

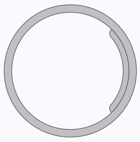
Manifolds

Manifolds of microchannel fluid coils are round tubes, manufactured from AA4045 aluminum alloy with AA3003-H14 or AA3005-H14 clad alloys, providing excellent performance in the brazing and improved corrosion resistance in applications. The selection of manifolds with diameters from 16 to 50mm and wall thickness from 1.2mm to 2.5mm ensures optimum choice for any system design and cooling media.

IMPORTANT

Selecting correct manifold size is essential for proper fluid distribution along microchannel tubes and optimal heat exchanger operation under partial and full heat loads. Consult Kaltra engineers for details.

Manifold specifications - fluid coils

Sectional view	Code	Tube diameter	Wall thickness	Applications
		mm	mm	
	16/120	16.0	1.20	UNIVERSAL
	20/150	20.0	1.50	UNIVERSAL
	25/150	25.0	1.50	UNIVERSAL
	28/140	28.0	1.40	UNIVERSAL
	30/150	30.0	1.50	UNIVERSAL
	32/175	32.0	1.75	LOW PRESSURE / MEDIUM PRESSURE
	32/250	320.0	2.50	HIGH PRESSURE
	38/200	38.0	2.00	UNIVERSAL
	38/250	38.0	2.50	HIGH PRESSURE
	42/200	42.0	2.00	UNIVERSAL
	42/250	42.0	2.50	UNIVERSAL / HIGH PRESSURE
	50/200	50.0	2.00	UNIVERSAL
	50/250	50.0	2.50	UNIVERSAL / HIGH PRESSURE

Fluid Connections

Coils can be configured with fluid connections of different types: copper connections for soldering, flanged, grooved, and threaded stainless steel or carbon steel connections, and aluminum connections. Connection geometry, length, diameter, and location on the coil manifolds are to the customer specification.

Connection Location

Fluid connections can be located on the side, face, at a selected arbitrary angle to the coil plane, and on manifold's ends, and chosen individually for fluid inlets and outlets.

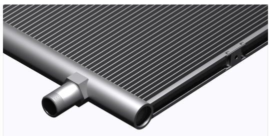


Fig. 6A: Side connection

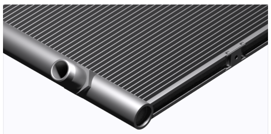


Fig. 6B: Angled connection

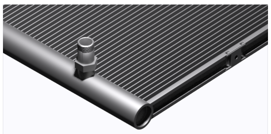


Fig. 6C: Face connection

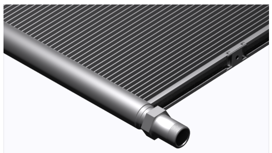


Fig. 6D: End connection

Connection Type

For installation flexibility, coils can be manufactured with fluid connections of various types:

- Sweat copper pipe connections
- Copper pipe with soldered in threaded brass fittings
- Aluminum flanged connections
- Stainless steel threaded, flanged, grooved connection pipes
- Carbon steel threaded, flanged, grooved connection pipes

Other connection types, multiple fluid inlet/outlet connections are available on request.

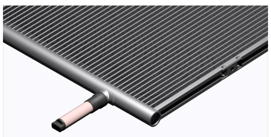


Fig. 7A: Sweat connection

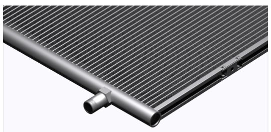


Fig. 7B: Threaded connection

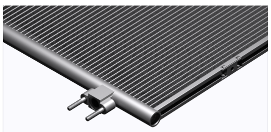


Fig. 7C: Flanged connection

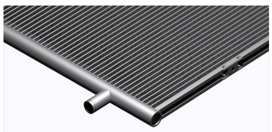


Fig. 7D: Grooved connection

IMPORTANT	Consult with Kaltra engineers to select a connection type suitable for fluid to be used.

Microchannel coils may be supplied with the following sealing fittings:

- Brazed-in end caps: required for coils charged with over 1 bar gas (nitrogen) pressure
- Rubber plugs: for coils charged with the pressure lower than 1 bar
- Plastic caps: for empty coils
- No fittings: for empty coils

Connection Orientation

Depending on incoming fluid pipework and other application requirements, coil connection pipes could be manufactured in the following geometries:

- Straight
- Elbowed at any angle in coil plane
- Elbowed in two or more planes

Connections could be of a single-pipe design or could be branched to dispense a fluid to and from coil manifolds.

Mountings and Fixtures

Kaltra offers more than a dozen of mounting brackets of various geometries attached to coil manifolds. These mountings are designed considering thermal expansion of the coil, to give flexibility in installation, and to firmly support coil weight. Additionally, coils can be manufactured with fixtures on side reinforcement bars. Customized mounting fixtures and accessories are available on request.

Protective Coatings

Corrosion, the deterioration of metals and alloys through a physical and/or chemical reaction with the environment, may affect the heat exchangers, specifically condenser and cooling/heating coils that are exposed in the environment, and this can lead to failures and performance degradation of the equipment in the cases of improper heat exchanger protection in corrosive locations. Potentially corrosive environments include coastal and marine areas, locations adjacent to industrial and urban areas, locations with proximity to heavy road traffic, factories, power plants, chemical plants, or the combinations of the above.

Unprotected heat exchangers, regardless of their type, are subjected to corrosion. Although all-aluminum microchannel coils tend to be less affected by corrosion compared to multi-metal coils, the protection must be applied in order to prevent deterioration in aggressive atmospheres. The highest level of corrosion resistance can be achieved with the right coil coating. For microchannel heat exchangers, the best coating option is factory-applied electrodeposition, which is also referred to as electrocoating (e-coating) or electrophoretic deposition, and produce uniform finishing with excellent corrosion resistance. The trivalent chromium process (TCP) coating is another efficient method of protection with excellent anti-corrosion properties. Kaltra offers both E-coating and TCP-coating as an option for all heat exchangers. Other coating types are available on request.

For more information on protective coatings and anti-corrosion solutions for microchannel heat exchangers, refer to appropriate Kaltra selection guidelines and manuals available online.

IMPORTANT	Consult with Kaltra engineers regarding the best suitable protective solution for your heat exchanger application.

CAUTION	Coated coils are not intended for liquid immersion applications.

IMPORTANT	The effect of protective coatings on heat transfer rate is typically 1%, and up to 5% on airside pressure drop. These values shall be taken into account when selecting a heat exchanger.

Epoxy Electrophoretic Coating

Epoxy electrophoretic coating (e-coating) is a process based on the deposition of electrically charged particles out of a water suspension to coat a heat exchanger. During the process, paint is applied to a heat exchanger with particular film thickness regulated by the amount of applied voltage and builds up an electrically insulating layer. The deposition process is self-limiting and stops as the applied coating electrically insulates the surface of a heat exchanger – thus guaranteeing substantial film thickness and complete surface coverage for such complex-shaped parts as microchannel heat exchangers.

Electrocoat process includes four distinct phases:

- Pre-treatment: cleaning the heat exchanger surface and phosphating. This stage includes immersion degreasing, rinsing, and phosphating, which is essential to achieving performance requirements and guarantees that no contaminations in the form of acids or electrolytes enter the electrocoat bath
- Applying the coating in an electrocoat bath. The bath is filling with paint emulsion (10-20%), solvents, and deionized water (80% and more), which is used as a carrier for the paint solids. The electrocoat process is driven by a DC rectifier, used to control the amount of paint that is deposited onto the heat exchanger surface. Cathodic deposition method with positively charged paint particles which are attracted to negatively charged heat exchanger characterizes by better corrosion resistance and high UV resistance of the end-product – compared to the anodic process. Thank electrical attraction, paint particles also penetrate the flaws and cracks in the metal
- Post-coating rinsing. Excessive paint is removed from the heat exchanger surface during this stage, providing a higher level of efficiency and aesthetics
- Thermal curing using bake oven. This process cures and cross-links the paint film to ensure maximum performance and corrosion resistance for the heat exchanger

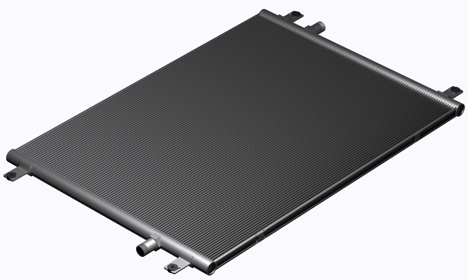


Fig. 8A: Uncoated microchannel heat exchanger

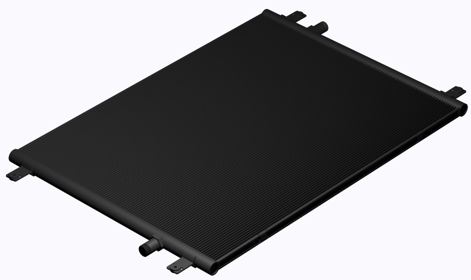


Fig. 8B: E-coated microchannel heat exchanger

Electrocoatings are typically made from polymeric resins, solvents and diluents, and pigments. Resin is a base of the paint which provides protection against corrosion and ultraviolet durability. Pigments and solvents provide coloring, glossing, and smooth appearance of the end product. The nature of the resins for the electrocoating can vary, but any type of resin feature functional groups in the backbone which allows them to become ionic in the presence of neutralizing agents. Electrocoating offers significant advantages over other coating technologies:

- High corrosion protection. Cathodic epoxy electrocoating with a film thickness of 20 microns withstands more than 6000 hours salt spray test performed in accordance with ASTM B117 standard, more than 4000 hours SWAAT performed in accordance with ASTM G85 Annex A3
- Uniform coating with no more than 1-2 micron variances across the coated surface of any shape complexity
- Eco-friendliness: heavy metal free, no hazardous air pollutants (HAPS), low levels of organic solvents, and low volatile organic compounds (VOC)
- Aesthetic quality

Performance test results: e-coated microchannel heat exchanger

Test	Standard	Results
Dry film thickness	ASTM D7091	15-50µm
Film hardness	ASTM D3363	>2H
Adhesion rating	ASTM D3359	$0.0<\Delta E<1.0$
Salt spray test	ASTM B117	6000hrs
Water resistance in 100%rH	ASTM D2247	>1000hrs
Hot water dip test	ASTM D870	>1000hrs
Specular gloss test	ASTM D523	60-90
Copper-accelerated acetic acid-salt spray test, CASS	ASTM B368	>1000hrs
Sea water acetic acid test, SWAAT	ASTM G85 Annex A3	>4000hrs
UV resistance test	ASTM G154	>2000hrs

E-coating is resistant to the following chemicals at ambient temperatures. Elevated temperatures can have an adverse effect on the corrosion durability of the coating product, depending on the specific environment. Data for the corrosion resistance of e-coating in specific corrosive environments available upon request.

E-coating chemical resistance

Acetates (all)	Acetic acid	Acetone	Acetylene	Acrylonitrile <10%
Alcohols (all)	Aldehydes (all)	Alum	Amines (all)	Amino acids
Ammonia	Ammonium hydroxide	Ammonium nitrate	Amiline	Benzene
Benzoic acid	Benzol	Borax	Boric acid	Butyl alcohol
Butyl cellosolve	Butyric acid	Calcium chloride	Calcium hypochlorite	Carbolic acid
Carbon dioxide	Carbon monoxide	Carbon tetrachloride	Carbonates (all)	Carbonic acid
Cetyl alcohol	Chlorides (all)	Chlorinated solvents (all)	Chlorine gas	Chloroform
Chromic acid	Citric acid	Creosol	Diesel fuel	Diethanolamine
Esters (all)	Ethers (all)	Ethyl acetate	Ethyl alcohol	Ethyl ether
Ethylene oxide	Fatty acid	Fluorine gas	Formic acid <10%	Formaldehyde <27%
Formic acid <10%	Freon	Fructose	Fuels (all)	Gasoline
Glucose	Glycols (all)	Hydrazine	Hydrocarbons (all)	Hydrochloric acid <10%
Hydrofluoric acid	Hydrogen	Hydrogen peroxide 5%	Hydrogen sulfide	Hydroxylamine
Iodides (all)	Iodine	Isobutyl alcohol	Isopropyl alcohol	Kerosene
Ketones (all)	Lacquers	Lactic acid	Lactose	Lauryl acid
Magnesium	Maleic acid	Menthol	Methanol	Methyl ethyl ketone
Methyl isobutyl ketone	Methylene chloride	Mustard gas	Naphthol	Nitric acid
Nitrides (all)	Nitrobenzene	Nitrogen fertilizers	Oils (mineral, vegetable)	Oleic acid
Oxalic acid	Ozone	Perchloric acid	Phenol 85%	Phenolphthalein
Phosgene	Phosphoric acid	Potassium chloride	Potassium hydroxide	Propane
Propyl alcohol	Propylene glycol	Salicylic acid	Salt water	Sodium bisulfite
Sodium chloride	Sodium hydroxide <10%	Sodium hypochlorite 5%	Sodium sulfate	Starch
Stearic acid	Sucrose	Sulfate liquors	Sulfates (all)	Sulfides (all)
Sulfites (all)	Sulfonic acid	Sulfur dioxide	Sulfuric acid 25-28%	Surfactants
Tannic acids	Tetraethyl lead	Toluene	Triethanolamine	Vinegar
Xylene				

Trivalent Chromium Process Coating

Trivalent chromium process (TCP) conversion coating is a type of conversion coating used to passivate aluminum alloys as a corrosion inhibitor. Unlike hexavalent chromium, trivalent chromium is non-toxic (both TCP bath and the resulting film contain no hexavalent chromium species) and fully complies with RoHS (Restriction of Hazardous Substances) requirements.
During TCP coating formation, activation of the aluminum surface leads to the reactions of oxygen reduction and hydrogen evolution, which results in the pH increase and the deposition of the TCP coating. TCP coating is characterized as a dense layer consisting of rounded particles hundreds of nanometre in size. The TCP coating consists of a two-layer structure, with zirconium-chromium oxide in the outer layer and aluminum oxide or oxyfluoride at the aluminum/coating interface. The TCP coating provides corrosion protection to aluminum alloys through suppressing the oxygen reduction reaction on aluminum alloy surfaces by acting as a protective barrier layer.
Trivalent chromium pretreatment demonstrates outstanding results for corrosion resistance and provides more than 3150 hours in neutral salt spray (ASTM B117), more than 2500 hours in sea water acetic acid test (SWAAT), and even longer for SLLA aluminum alloys used in Kaltra heat exchangers. TCP coating also exceeds dry tape adhesion requirements for ASTM D3359.

Performance test results: TCP-coated microchannel heat exchanger

Test	Standard	Results
Adhesion rating	ASTM D3359	$0.0<\Delta E<1.0$
Salt spray test	ASTM B117	3150hrs
Sea water acetic acid test, SWAAT	ASTM G85 Annex A3	>2500hrs

Applying of trivalent chromium process coating consists of the following steps (post-treatment is required depending on aluminum alloy grade being processed):

- Removing pollutants from the heat exchanger surface by rinsing and degreasing in an alkaline bath
- Immersion in a desmutting bath in order to remove coarse intermetallic particles and native oxide
- Forming of TCP coating by immersion of the heat exchanger in a trivalent conversion bath
- Post-treatment to reinforce the conversion layer and drying with the dried air stream
- The heat exchanger is rinsed in deionized water following each step

DESIGN

Bending

Microchannel coils can be supplied bent as per application requirements. Both uncoated and coated coils are well suited for bending.

IMPORTANT In order to optimize shipping costs, microchannel coils can be bent on-site with appropriate machinery and tools. Consult Kaltra for the recommended sequence of operations for bending.

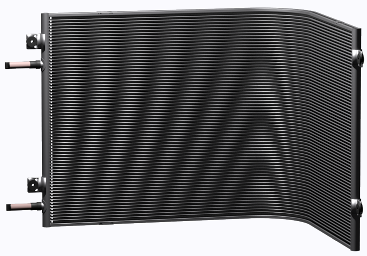


Fig. 9A: Bent coil (front view)

Fig. 9B: Bent coil (back view)

Microchannel tube width	Minimum bending radius
mm	mm
≤ 16.0	80
≤ 20.0	100
≤ 25.4	120
> 25.4	180

Casings and Assemblies

As an option, microchannel coils can be configured and supplied in galvanized steel casings tailored to customer applications. Casings are airtight construction, ready-to-install components.

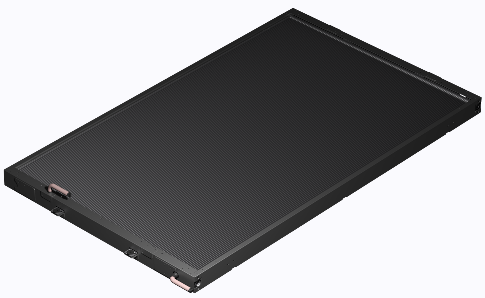


Fig. 10A: Steel-cased microchannel coil

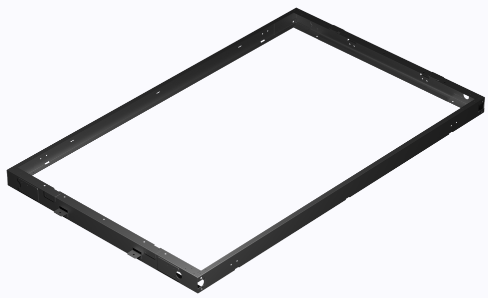


Fig. 10B: Case assembly

STORAGE, HANDLING, AND TRANSPORTATION

Packing

Microchannel heat exchangers are supplied tightly packed in vertical position in wooden crates to avoid sliding, moving, and deformation of the coils during transportation. Crates are reinforced with wooden beams on the bottom side, and on the top are closed with screws. Internal packing includes partitioning cardboards and plastic sealings to prevent heat exchangers from coming into contact with each other and with the crate walls.
Supplied heat exchangers are sealed and charged with nitrogen gas at 0.05÷0.20MPa pressure (except those shipped by air).

IMPORTANT Handling instructions and crate content can be identified by reading stickers applied to the crate walls.

Storage

Microchannel heat exchangers shall be stored indoors in a dry and clean environment under the following conditions:

- The storage temperature range is -40°C to 120°C (-40°F to 250°F)
- Avoid exposure to direct sunlight
- During storage, exposure to corrosive environments shall be effectively avoided
- Metal chips and/or copper or steel dust can cause galvanic corrosion: storage and installation areas must remain clean and separate from machining or welding areas
- Heat exchangers shall be stored in a vertical position, preferably in the original package until they are installed in the equipment
- Do not stack heat exchangers flat on top of each other
- Improper storage and stacking of microchannel heat exchanger can cause premature corrosion or deformation and may reduce its service life
- With prolonged storage, suitable measures for additional corrosion protection should be implemented following consultation with Kaltra

IMPORTANT Heat exchangers must be stored free of fluids and with protective caps on fluid connection pipes to avoid corrosion and/or contamination.

IMPORTANT Avoid storing heat exchangers in horizontal position for a long period of time.

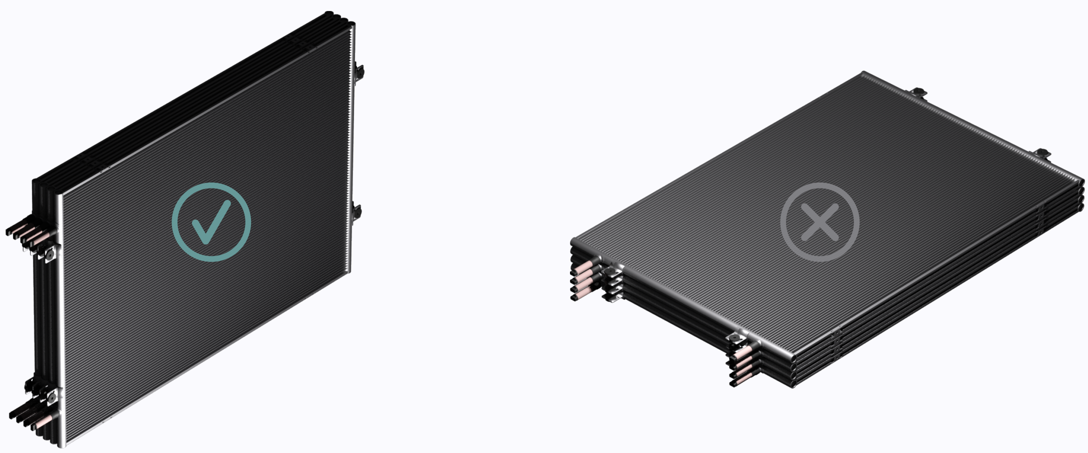


Fig. 11. Position for long-term storage

Handling

Although microchannel coils are robust construction, care must be taken to ensure that damages and leaks are not caused by improper handling. Airside fins of microchannel coil are harder to be bent compared to those used in finned tube coil designs. The lightweight construction of microchannel allows handling the coil by hand.
Use lifting lugs or mountings located on microchannel coils for assisted installation and removal and avoid the use of straps being wrapped around the coil surface.
Clean the heat exchanger prior to installation, if necessary. Do not use chemicals for cleaning. Rinse only! For details of the cleaning procedure, refer to the appropriate section of the present manual.

IMPORTANT	To avoid damages, never lift the microchannel coil by the fluid connection pipes.

CAUTION	Avoid dropping, impacting, placing heavy objects on top of, stepping on microchannel coil as this may cause coil warps.

CAUTION	Always consider maximum weight of parts to handle. Use appropriate lifting and supporting devices to move heavy items.

CAUTION	Check the heat exchanger is as ordered, discrepancies or transit damage should be reported to Kaltra immediately. Care should be taken to ensure the unit does not sustain damage before it is installed. It is strictly prohibited to use the connections, which are delicate parts of the coil, as anchoring points when lifting or handling the unit. This would cause serious damage to the coil and serious risks for the safety of persons and goods.

Transportation

Heat exchangers can be transported individually or stacked on wooden pallets. It is recommended to transport heat exchangers for long-distance hauls in the original package.
Avoid continuous vibration during transportation, as this may cause heat exchanger damage.

CAUTION	During transportation and handling, avoid exerting undue pressures, accidental hits, and avoid any shocks that could damage the product.

CAUTION	Kaltra accepts no responsibility for any mishandlings during unit lifting or moving.

INSTALLATION

The installation should be carried out by trained and experienced specialists in accordance with common refrigeration practice, recommendations of the present manual, local rules and requirements and directives in force.

IMPORTANT	Kaltra takes no responsibility for improper installation, which may cause heat exchanger malfunction or damage to the equipment.

System designer and installing engineer should be responsible for checking and observing all the requirements in accordance with system application and installation.

IMPORTANT	Prior to installation, clean heat exchanger, if necessary. Refer to the appropriate section in the present manual for cleaning instructions. Evacuate nitrogen gas from the coil. It is recommended to insert connection plugs back and not to remove plugs until required.

Coil Orientation

Before installation, identify the location of inlet and outlet fluid connections. Refer to the product label, identification marks on connection pipes, or documentation supplied with a heat exchanger to identify inlet and outlet connections.

Inclination Angle

The fluid coil is possible to install at any inclination angle, depending on application requirements and designer choice.

Locating Fans

Uniform airflow distribution over the coil face is essential to achieve maximum heat transfer performance. Select and position the fans for optimum air stream distribution. Determine the required distance from fan impeller to the coil face.

Mounting

Heat exchanger mounting shall be conducted with attention to the airtightness of assembly, thermal expansion/contraction of the coil due to ambient and/or process fluid temperature change, vibrations induced by unit components like fans and compressors. Special attention shall be paid to eliminate direct contact between aluminum coil core and other equipment parts/components made of dissimilar metals as this may cause galvanic corrosion.

Airtightness

In order to maximize heat exchanger performance, it shall be sealed with rubber or plastic band all round. This way, airtight minimizes airflow waste, even in the case of thermal coil contraction. Inter alia, rubber/plastic band isolates fluid coil from the framing, thus eliminating a possible source of corrosion, while minimizes vibration issues.

Thermal Expansion

IMPORTANT	The thermal expansion of aluminum is higher than most other metals, and this shall be taken into account during the system design phase and its installation.

The table herein shows the minimum recommended allowance for thermal expansion based on the heat exchanger dimensions, assuming an 80°C temperature differential. If high ambient or low ambient operation is expected, thermal expansion allowance shall be increased based on the maximum fluid temperature, minus the lowest expected ambient operating temperature.
To avoid the risk of coil damage caused by thermal expansion, microchannel heat exchangers shall be mounted with fixtures allowing the coil to expand freely in both horizontal and vertical directions. The same shall be taken into account when locating the fluid pipe supports.
Inlet/outlet fluid connections shall be supported so that the joints are not exposed to stress or tension.

Thermal expansion allowances	
Heat exchanger length/width	Thermal expansion allowance[1]
mm	mm
≤200	0.25
≤350	0.40
≤500	0.60
≤650	0.75
≤800	0.90
≤1000	1.10
≤1250	1.30
≤1500	1.50
≤1750	1.75
≤2000	2.00
≤2250	2.25
≤2500	2.50
≤2750	2.75
≤3000	3.00

[1] - for 80°C temperature differential

Vibration and Stresses

Vibrations that exceed allowable range may cause leaks and other failures of microchannel heat exchangers. The below table indicates the allowable vibration range. Make sure the levels of vibrations do not exceed specified limits.

Vibration allowances		
Property		Allowance
Amplitude	mm	≤0.15
Peak amplitude	mm	0.25
Acceleration	$m{\cdot}s^{-2}$	≤20

⚠ **CAUTION** Warranty does not cover the cases related to heat exchanger damage caused by exceeding vibrations.

The recommended method of eliminating vibrations is using rubber/plastic washers on coil mountings and/or install heat exchanger manifolds with rubber/plastic supports.

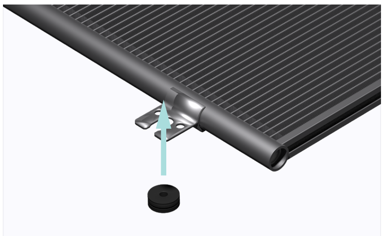


Fig. 12A: Isolating washer

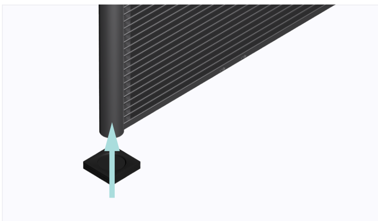


Fig. 12B: Isolating manifold support

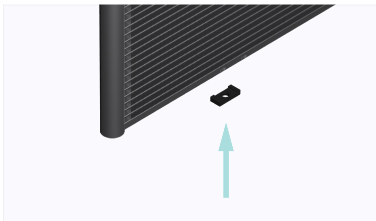


Fig. 12C: Isolating insert

Preferable methods of mounting that allow its free thermal expansion/contraction, and isolate it from vibrations are shown on Fig. 12A-12C.

Connecting To Pipework

Fluid coils with sweat copper connections feature adhesive shrink sleeve to avoid corrosion between these dissimilar metals - copper and aluminum. The protection of this joint is required when connecting the coil to the fluid pipework by brazing. Place a wet rag or heat paste over the shrink sleeve during the brazing process.

⚠ **CAUTION**	When brazing in the new microchannel coil, the temperature at the copper-to-aluminum joint must not exceed 250°C. Failure to follow this requirement could result in coil damage.

ⓘ **IMPORTANT**	Place an aluminum splatter shield using aluminum foil tape during the brazing to protect the heat exchanger from galvanic corrosion associated with splatter during the brazing process.

Bending Procedure

In order to reduce costs associated with shipping and handling of heat exchangers, microchannel coils can be supplied flat for further bending using customer's bending machines. Both uncoated coils and coils with protective coatings are suitable for bending. Follow the below instructions when bending microchannel heat exchangers.

ⓘ **IMPORTANT**	Perform a trial bending run for the specific heat exchanger to verify bending parameters and ensure no damages occurred during the bending process.

- Observe the minimum allowable bend radius given in the present manual. Do not extrapolate minimum radius values provided in the present manual. Consult with Kaltra engineers for a minimum bending radius of the tubes not listed in the present manual
- Prior to bending operation, ensure heat exchanger is flat and undamaged. Make sure the heat exchanger is loaded correctly into the bender. Keep the flat tubes perpendicular to the spindle when bending the coil
- Slow down bending machine speed for better results
- Avoid heat exchanger sliding along the table. Fix the coil firmly
- Bending multi-bend coils on a horizontal spindle bender can cause cantilevered loads resulting from the dead weight of the unsupported bent legs

Fluid Circuit Requirements

⚠ **CAUTION**	Fluid coils are only suitable to use in closed-loop fluid circuits!

⚠ **CAUTION**	The fluid circuit must be free of air, gases, and solid contaminants to avoid performance losses, corrosion, and damages to the microchannel fluid coil.

⚠ **CAUTION**	Over-pressurization of the system can cause an explosive discharge of process fluid, loss of it, environmental pollution, equipment damage, injury, or death. Use extreme caution when charging the system. Do not pressurize the system higher than the design pressure marked on the unit's nameplate.

⚠ **CAUTION**	Heat exchangers are shipped with a holding charge of inert gas to guard against contamination or moisture during transportation and storage. The charge should be checked to indicate if leaks are present before evacuation. If the charge appears to be either partially or totally lost, then the heat exchanger shall be checked for signs of physical damage.

⚠ **CAUTION** Pressure testing can be dangerous if not properly conducted. Personnel undertaking pressure testing must be technically competent and suitably qualified.

Fluid Velocity

High fluid velocities may lead to erosion of microchannel tubes. To avoid the issue, it is recommended not to exceed tubeside fluid velocities higher than 1.5m/s.

Filtration

Ports of microchannel tubes are of small diameters, and therefore Kaltra recommends installing fluid filters to avoid particles and contaminants entering the heat exchanger. The recommended sieve size of a mesh strainer is 0.25mm or less. However, design engineers may select other sieve sizes based on the microchannel tube port size.

⚠ **CAUTION** Warranty claims related to damages resulting from excessive tubeside fluid velocity, will not be honored.

Process Fluid Requirements

To ensure the long operating lifespan for microchannel fluid coil, the following conditions for the process liquid shall be in place:

- Fluid pH value shall be in the range between 6.0 and 8.5 to prevent corrosion of the aluminum, which may be caused by an oxide layer dissolving at extreme pHs (in both acidic and basic environments)
- The addition of corrosion inhibitor is recommended for ensured coil protection, e.g., those based on monopropylene glycol or sodium molybdate
- Remove air and other gases from the fluid circuit
- Zincating pre-treatment of inner surfaces of the coil (available as an option) is recommended as additional protection against corrosion

⚠ **CAUTION** Warranty claims related to damages resulting from contamination of process fluid, will not be honored.

MAINTENANCE

Timely servicing is essential to maintain optimum performance of the microchannel heat exchanger and ensure its long operating life. Observe Kaltra's recommendation on the after-sale service described below.

⚠ **CAUTION**	All work must be carried out by technically trained competent personnel. Prior to servicing heat exchangers, be sure to disconnect the power supply and lock power switch to prevent the power from accidentally being turned on.

⚠ **CAUTION**	It is owner responsibility to provide scheduled maintenance in accordance with the schedule and requirements mentioned below. Incorrect maintenance within warranty period invalidates warranty obligations of the manufacturer. It is important to follow maintenance schedule as a minimum not only for warranty period but for the whole life time of the heat exchanger.

- All service records shall be accurately documented
- Appropriate service tools, test and safety equipment should be employed for maintenance works

Maintenance Schedule

The maintenance schedule indicates the time between maintenance operations. It is necessary to carry out all maintenance tasks described below in case the system has been stopped for a period longer than three months.

Maintenance schedule	
Item	Work description
Interval: 6 months	
Cleaning[1]	Check if heat exchanger cleaning is required and perform cleaning procedure as described in the present manual.
Check for vibrations	Check if vibrations do not exceed allowable limits and eliminate vibration source, if necessary.
Check heat exchanger condition	Check the heat exchanger visually for mechanical damages; check the condition of rubber/plastic elements and replace, if necessary.
Leakage check[1]	Check the heat exchanger visually for leakages or traces of fluid spill outs. Pay special attention to fluid connections. Perform repair, if necessary.
Interval: 12 months	
Assembly check	Check all bolted connections for tightness. Tighten connections, if necessary.
Check for corrosion[1]	Check the heat exchanger for traces of corrosion.
Coating check[1]	For heat exchangers with protective coatings, check the coating for scratches. Repair, if necessary.

[1] - Inspection and maintenance intervals should be shortened according to the actual situation if the heat exchanger operated in aggressive, corrosive, or highly-polluted environments.

Cleaning Procedure

The build-up of dirt on the aluminum surface, which is exposed to moisture, can reduce the durability of the heat exchanger. Regular cleaning of the heat exchanger ensures its high efficiency in operation.

⚠ **CAUTION**	Warranty claims related to cleaning damage or corrosion resulting from chemical coil cleaners, will not be honored.

In comparison to finned tube heat exchangers, microchannel coils tend to accumulate dirt and debris on the surface rather than inside, making them easy to clean. The cleaning procedure for microchannel heat exchangers includes the following steps:

- Remove dirt and debris from the coil surface with a soft brush or vacuum cleaner with a soft attachment or compressed air blower (3 to 5 bar)
- Rinse the coil with water (pH in range 4.5÷8.5), including general detergents. Do not use chemicals to avoid corrosion potential. Use the water-atomizing nozzle to prevent possible damages from the water stream. Water pressure must be controlled to prevent damage to the fins: sprayer nozzle pressure should not exceed 40 bar
- Microchannel coils could retain water after cleaning. Blow off or vacuum out the residual water from the coil to speed up drying

⚠	**CAUTION**	During cleaning, wear proper personal protective equipment such as a face shield, gloves, and waterproof clothing.

⚠	**CAUTION**	Brush the coil in the longitudinal direction of fins only.

⚠	**CAUTION**	Align the cleaning nozzle at the angle to coil fins. Nozzle angle should not exceed 25 degrees to the coil surface.

⚠	**CAUTION**	During high-pressure cleaning, keep the minimum distance of 400mm from the spraying nozzle to the coil surface.

ⓘ	**IMPORTANT**	Clean the coil from the opposite direction of normal air flow as this allows the debris to be pushed out rather than forced further into the coil.

Repair

If the leak is found to be within the microchannel tubes of the coil, a field repair kit is available from Kaltra. A heat gun and needle-nose pliers are required tools for the repair procedure.

⚠	**CAUTION**	Sharp edges! The service procedure described in the present manual involves working around sharp edges. To avoid being cut, technicians must put on all necessary personal protective equipment, including gloves and arm guards. Failure to follow recommendations could result in injury.

- Locate the source of the leak
- Evacuate any remaining fluid in the damaged coil circuit
- Using needle-nose pliers, clear away approximately 1cm of fin material from each side of the leak to gain sufficient access to the repair area
- Prepare the aluminum wrapper by cutting it to approximately 5cm in length and folding it in half
- Using the aluminum oxide sandpaper remove any rough edges on the upper and lower portion of the tube and also scuff the inside the aluminum wrapper
- Remove the powder flux from the repair area by vigorously brushing the upper and lower portion of the tube with the round wire brush
- Clean the surfaces with the supplied alcohol pad in order to remove any dirt, debris, and oils. Allow the surfaces to air dry fully
- Combine two equal portions of the two part epoxy together
- Apply the epoxy with the application tool to the leak area and along the cleared fin section
- Place a small portion of remaining epoxy to the inside of the aluminum wrapper
- Place the aluminum wrapper over the leak area
- Crimp the aluminum wrapper with the needle-nose pliers
- With the use of a heat gun, apply equally distributed heat to the repaired area for roughly 15-20 minutes until epoxy changes from red to gold in color. Allow an additional 30 minutes for the epoxy to cure before leak checking the system
- Recharge unit with working fluid

SERVICES

Engineering

Kaltra specialists quickly and professionally help customers to choose the necessary type and configuration of the microchannel heat exchangers, calculate technical parameters, determine the best suitable type of aluminum alloys, connections, mountings options, as well as other characteristics in accordance with actual requirements and recommendations.
In accordance with the agreed parameters, Kaltra engineers promptly prepare the corresponding drawings, 3D models, and other necessary documentation. Drawings include complete details, dimensioning, tolerances, and heat exchanger specification.

Selection Software

MCHE selection software includes condenser, evaporator, heat pump, and water coils, making it a complete selection and calculation tool for refrigeration professionals.
The software provides selections and ratings for microchannel heat exchangers which enables the user to select the best-suited product based on several deciding parameters such as heat exchanger application, cooling capacity, refrigerant, evaporation and condensation temperatures, airflow and air temperature and other critical variables in refrigeration systems.
The latest version of MCHE selection software is available for download at Kaltra website: https://www.kaltra.com/software-inquiry
Online information on Kaltra microchannel heat exchangers: https://www.kaltra.com/microchannel-heat-exchangers

NOTES

Kaltra GmbH

Head office:

Viktualienmarkt 8
80331 Munich
Germany

+49(0)911 715 32021

info@kaltra.de

www.kaltra.com

Kaltra GmbH
Viktualienmarkt 8 • 80331 Munich • Germany
info@kaltra.de
+49(0)911 715 32021