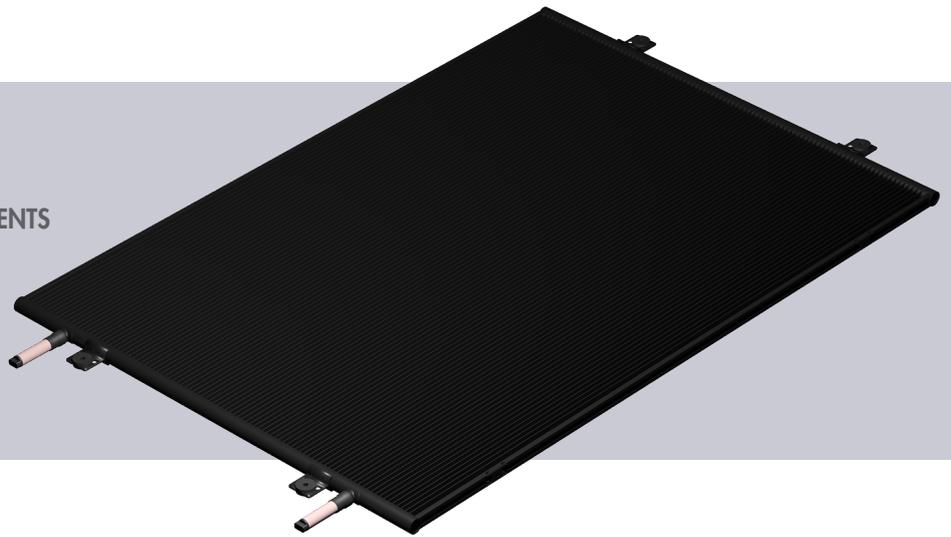


Protective Coatings

FOR MICROCHANNEL HEAT EXCHANGERS

- ▶ CORROSION AND CORROSIVE ENVIRONMENTS
- ▶ ALLOYS AND COATINGS
- ▶ MAINTENANCE



SELECTION GUIDE
ENGLISH



INTRODUCTION

Purpose of Present Guide

The present document is a guide for material and protective coating selection for microchannel heat exchangers operating in corrosive environments and for their maintenance. Kaltra recommends reading this guide carefully before commencing any work.

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

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CONTENT

Introduction	1
Purpose of Present Guide	1
Service Contacts	1
Corrosion	3
Types of Aluminum Corrosion	3
Atmospheric Corrosion	3
Uniform Corrosion	3
Galvanic Corrosion	3
Pitting Corrosion	3
Erosion Corrosion	3
Corrosive Environments	4
Urban	4
Industrial	4
Coastal/Marine	4
Rural	4
Classification	4
Corrosion Protection	5
Material Selection	5
Alloy Series 3xxx	5
Alloy Series 4xxx	5
Alloy Series 7xxx	5
Long-Life Alloy Series 9xxx	5
Brazing Process	5
Coatings	6
Epoxy Electrophoretic Coating	6
Trivalent Chromium Process Coating	8
Corrosion Resistance Tests	8
ASTM G85 Sea Water Acetic Acid Test	9
ASTM B117 Salt Spray Test	9
Recommendations on Coating Selection	9
Maintenance	10
Visual Inspection	10
Cleaning Procedure	10

CORROSION

Corrosion, the deterioration of metals and alloys through a physical and/or chemical reaction with the environment, is expensive. Heat exchangers used in HVAC equipment, specifically condenser and cooling/heating coils, are exposed in the environment, and this can lead to corrosion, 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, 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 copper-aluminum finned-tube 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 aluminum alloy selection and coil coating.

Types of Aluminum Corrosion

Corrosion is the chemical reaction of metal - aluminum in the case of microchannel heat exchangers - with its environment, which leads to the deterioration of the properties of metals, aluminum in this case.

Aluminum is a very reactive metal with a high affinity for oxygen and highly resistant to most environments and to a great variety of chemical agents. This resistance is due to the inert and protective character of the aluminum oxide film, which forms on the metal surface. In most environments, the rate of corrosion of aluminum decreases rapidly with time. In only a few cases, the corrosion rate approximate to the linear. Although the oxide film is extremely thin, it forms a protective barrier between the metal and the surrounding medium as soon as the metal comes into contact with an oxidizing environment. The physical-chemical stability of the oxide film determines the corrosion resistance of the aluminum.



IMPORTANT

Aluminum alloys may corrode in several different forms. Recognizing the forms of aluminum corrosion is a crucial step to determine the appropriate protection for your microchannel heat exchanger.

Atmospheric Corrosion

Atmospheric corrosion is corrosion of aluminum exposed to the air and its pollutants. The corrosivity of the atmosphere to aluminum varies from one geographic location to another, depending on weather factors: temperature changes, amount and type of air pollutants, and proximity to water bodies.

Uniform Corrosion

Uniform corrosion occurs in the solutions where pH is either very high or very low, or at high potentials in electrolytes with high chloride concentrations. In acidic (low pH) or alkaline (high pH) solutions, the aluminum oxide is unstable and thus non-protective.

Galvanic Corrosion

Galvanic corrosion creates the most significant number of corrosion problems for aluminum alloys. Galvanic corrosion, or dissimilar metal corrosion, occurs when aluminum is electrically connected to more noble metal, and both are in contact with the same electrolyte.

Pitting Corrosion

Pitting of aluminum alloys occurs if the electrolyte contains a low level of chloride anions and if the alloy is at a potential above the so-called pitting potential. Pitting corrosion is characterized by the formation of irregularly shaped cavities on the surface of the aluminum. Aluminum is prone to pitting corrosion in a media with pH out of neutral range. Pitting corrosion occurs when the metal is put into continuous or intermittent contact with aqueous media.

Erosion Corrosion

Erosion corrosion of aluminum occurs in high-velocity water. Erosion corrosion of aluminum is accelerated at high pH values, especially with high carbonate and high silica content of the water. To prevent erosion corrosion, one may change the water chemistry or reduce water velocity of the water, or both. For the water chemistry, the pH must be below 9, and the carbonate and the silica levels must be reduced.

Corrosive Environments

During the process of heat exchanger coating selection, it is required to determine if the application environment is corrosive to aluminum, and the severity of corrosion that varies considerably from one environment to another. Furthermore, application details shall also be taken into account. For instance, it is highly recommended to use protective coatings for adiabatic-assisted systems where heat exchangers are exposed to constant contact with water and moisture.

Industrial

An industrial atmosphere is characterized by pollution composed mainly of sulfur compounds such as sulfur dioxide, a precursor to acid rain, and nitrogen oxides, the backbone of smog in modern cities. Sulfur dioxide from burning coal or other fossil fuels is picked up by moisture on dust particles as sulfurous acid. Contaminants in an industrial, atmosphere, plus humidity, produce a corrosive, wet, acid film on exposed surfaces.

In addition to the typical industrial atmosphere in or near chemical plants, other corrosive pollutants may be present. These are usually various forms of chloride, which may be much more corrosive than the acid sulfates. The reactivity of acid chlorides with aluminum is more pronounced than that of other pollutants such as phosphates and nitrates.

Urban

Highly populated areas generally have high levels of automobile emissions and increased rates of building heating fuel combustion. Both conditions elevate sulfur oxide and nitrogen oxide concentrations. Corrosion severity in these environments depends on pollution levels, which in turn depends on several factors, including population density. Often, urban areas shall be considered as industrial environments.

Coastal/Marine

A marine atmosphere is laden with fine particles of sea mist carried by the wind to settle on exposed surfaces as salt crystals. The quantity of salt deposited can vary significantly with wind velocity, and it may, in extreme weather conditions, even form a very corrosive salt crust. The quantity of salt contamination decreases with distance from the ocean and is greatly affected by wind currents. The marine atmosphere also includes the space above the sea surfaces where splashing and heavy sea spray are encountered. The equipment exposed to these zones is subjected to the worst conditions of intermittent immersion with wet and dry cycling of the corrosive agent.

Rural

Rural atmospheres are typically the most benign and do not contain strong chemical contaminants unless one is close to a farm operation where byproducts of various waste materials can be corrosive to aluminum. In the latter case, such environments shall be interpreted much like industrial applications.

Arid or tropical atmospheres are special variations of rural environments. In dry climates, there is little or no rainfall, but there may be high relative humidity and occasional condensation. In the tropics, in addition to the high average temperature, the daily cycle includes high relative humidity, intense sunlight, and long periods of condensation during the night. Such conditions may produce a corrosive environment.

Classification

ISO's testing standards for protective paint systems were developed through long-term material weight loss and surface degradation testing in different corrosive environments. ISO classifies environments in corrosivity categories of C1 through C5-M or C5-I based upon this loss.

ISO 12944-5:2019 corrosivity categories				
Category	Corrosivity	Corrosivity rate ^{1,2} Aluminum, g/m ²	Example environments	Example environments
			Indoor	Outdoor
C1	Very low	~0	Heated buildings w/ clean atmospheres	-
C2	Low	$r \leq 0.6$	Unheated buildings where condensation can occur	Environments with low levels of pollution, mainly rural
C3	Medium	$0.6 < r \leq 2.0$	Production sites w/ high humidity and some air pollution	Cities & industrial environments w/ moderate sulfur dioxide pollution
C4	High	$2.0 < r \leq 5.0$	Chemical industry, ship- and boat yard	Industrial areas and coastal areas w/ moderate salinity
C5-I	Very high (industrial)	$5.0 < r \leq 10.0$	Sites w/ permanent condensation & high pollution impact	Industrial areas w/ high humidity and aggressive environment
C5-M	Very high (maritime)	$r > 10.0$	Sites w/ a high degree of condensation & high pollution impact	Coastal environments, off-shore installations w/ high salt content

¹ - Mass loss of aluminum (g/m²) after one year of exposure to atmospheres with different corrosivity categories (ISO 9223:2012)

² - Corrosion rates shown are calculated as uniform corrosion

CORROSION PROTECTION

To prevent corrosion, proper aluminum alloy selection, surface treatment, and field maintenance are necessary. There are several corrosion prevention options and methods that can be adopted for all-aluminum heat exchangers. These include the application of protective coatings and regular surface cleaning.

Material Selection

The durability of aluminum enables its use in many applications, and in doing so it may come into contact with aggressive environments. To achieve strength, aluminum is alloyed with other elements to improve its mechanical and corrosion properties. Kaltra uses aluminum alloys of series 3xxx, 4xxx, 7xxx, and long-life alloys 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%

Alloy Series 3xxx

Manganese is the primary alloying element in this non-heat-treatable series, often with smaller amounts of magnesium added. However, only a limited percentage of manganese can be effectively added to aluminum. AA3003 is a popular alloy for general purpose because it has moderate strength and excellent workability and widely used in heat exchanger applications.

Alloy Series 4xxx

4xxx series non-heat-treatable alloys are combined with silicon, which can be added in sufficient quantities to lower the melting point of aluminum, without producing brittleness. Because of this, the 4xxx series produces excellent brazing alloys where a lower melting point is required.

Alloy Series 7xxx

Zinc is the principal alloying agent for this series, and when magnesium is added in a smaller amount, the result is a heat-treatable, very high strength alloy. 7xxx Series is a heat-treatable alloy. The heat treatment of the 7xxx series alloys is complex, involving a range of heat treatments that have been developed to balance strength and stress corrosion cracking performance.

Long-Life Alloy Series 9xxx

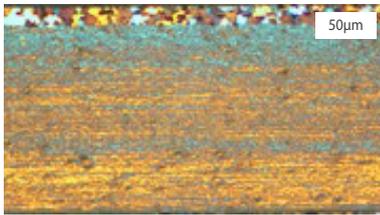
The 9153, 9170, and 9108 alloys have been developed, especially for HVAC microchannel heat exchangers. These alloys provide high inherent corrosion resistance - among the best ever developed. The 9xxx series alloys showed more than 100% longer SWAAT ASTM G-85 A3 lifetime compared to AA3102 aluminum alloy, indicating significantly better resistance against corrosion.

Brazing Process

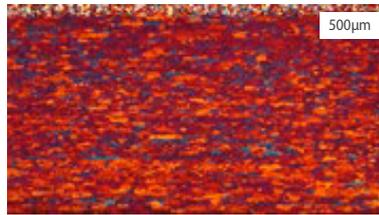
The manufacturing of microchannel heat exchangers is an industrial CAB process - stands for controlled atmosphere brazing. CAB process is a flux-aided furnace brazing process under an inert shielding gas (nitrogen). Flux is required to clean the surfaces of the aluminum parts from oxides. For its microchannel 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. Several types can be applied to aluminum tubing during the manufacturing process. Zinc arc spray is one of the alternatives.

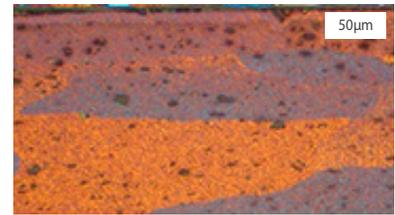
Putting a zinc layer on top of an aluminum alloy protects the core of the tube by providing a preferred path for corrosion to spread. Zinc is a less noble element compared to aluminum alloys. Zinc acts as a sacrificial layer guiding corrosion along the surface of the tube instead of through the tube walls. This corrosion behavior will lengthen the lifetime of the tube. With zinc arc spray, 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.

Coatings

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.

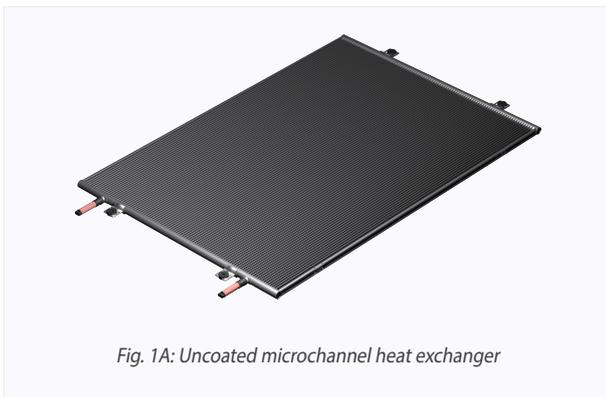


Fig. 1A: Uncoated microchannel heat exchanger

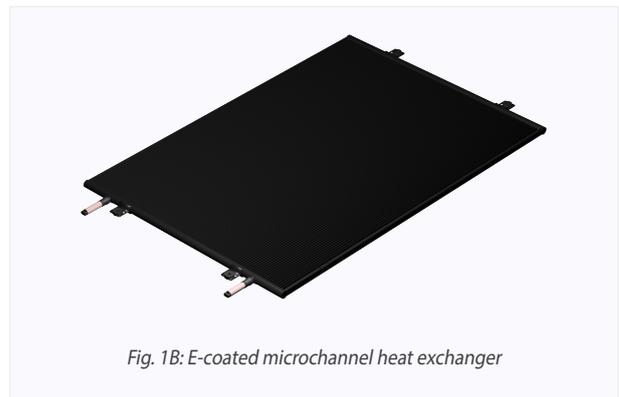


Fig. 1B: E-coated microchannel heat exchanger

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



CAUTION

E-coated coils are not intended for liquid immersion applications.

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<ΔE<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		



IMPORTANT

The effect of epoxy electrophoretic coating 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.

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 9153 aluminum alloy 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< Δ 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



CAUTION

TCP-coated coils are not intended for liquid immersion applications.



IMPORTANT

The effect of TCP-coating 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.

Corrosion Resistance Tests

Several tests can be used to measure the effectiveness of protective coatings for HVAC coils. These testing processes have evolved over the years as various organizations have tried to provide the most accurate information to engineers, manufacturers, and businesses that need to protect their investments. Most of the test methods use a cyclic approach that is intended to replicate actual environmental conditions. The tests typically involve a series of wet and dry cycles, and some include additional exposure to ultraviolet light, heat, humidity, etc.

On request, Kaltra provides results for microchannel heat exchangers tests accomplished as per ASTM G-85 Annex A3 (SWAAT) requirements made by independent laboratories.

ASTM G85 Sea Water Acetic Acid Test

There are still no accepted accelerated corrosion test specifications for the HVAC industry available. Consequently, SWAAT ASTM G85 A3, which has been used in the automotive industry, is often utilized as a type of qualification test for HVAC applications. The test accelerates the corrosion rate of the aluminum alloys and is used to estimate the lifespan of the aluminum alloy products in the real condition. As a straightforward estimate, testing a specimen for 24 hours is equivalent to one year operating in real life.

In accordance with ASTM G85 Annex A3 (SWAAT), a test specimen is placed in a chamber and exposed to a changing atmosphere that comprises the repeating cycle at a constant chamber temperature of 49°C:

- 30 minutes exposure to a continuous indirect spray of acidified (pH 2.8 to 3.0) synthetic seawater solution, which falls-out on to the specimens at a rate of 1.0 to 2.0 ml/80cm²/hour
- 90 minutes of exposure to high humidity (98%) air should not exceed 40 bar

ASTM B117 Salt Spray Test

The ASTM B117 salt spray test uses a closed testing chamber in which salt water (5% sodium chloride) solution is atomized by means of spray nozzles using pressurized air. The temperature in the chamber is maintained at 35°C; the pH range is from 6.5 to 7.2pH. The test subject is continuously exposed to the same corrosive atmosphere inside the chamber, then evaluated after removal from the environment.

Salt spray testing is relatively inexpensive, quick, well standardized, and reasonably repeatable. Nowadays, the ASTM B117 testing used mostly for maintaining coating processes on a comparative basis.

Recommendations on Coating Selection

Based on extensive research and field experience, Kaltra recommends the following combinations of corrosion protection options for microchannel heat exchangers, for various corrosive environments:

Corrosion-protective options						
Corrosion-protective option	Corrosivity category ¹					
	C1	C2	C3	C4	C5-I	C5-M
Uncoated MCHE	✓	✓	✗	✗	✗	✗
Uncoated MCHE 9153/9170	✓	✓	✓	✗	✗	✗
TCP-coated MCHE	✓	✓	✓	✓	✗	✗
E-coated MCHE	✓	✓	✓	✓	✓	✗
TCP-coated MCHE 9153/9170	✓	✓	✓	✓	✓	✗
E-coated MCHE 9153/9170	✓	✓	✓	✓	✓	✓

¹ - According to ISO 12944-5:2019

MAINTENANCE

Timely and regular cleaning is essential to protect microchannel heat exchangers from corrosion and ensure their long operating life. Follow Kaltra's recommendations and best practice for the heat exchangers cleaning procedure listed below.

Visual Inspection

Regular visual inspections are essential to increase the reliability and lifetime of microchannel heat exchangers. During every scheduled maintenance procedure, check the heat exchanger for mechanical damages, leakage, or corrosion signs. If any of the above revealed, provide additional diagnostic to determine and overcome the reason for the problem.

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, 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.

KALTRA

Kaltra GmbH

Head office:

Viktualienmarkt 8
80331 Munich
Germany



+49(0)911 715 32021



info@kaltra.de



www.kaltra.com

