# MICROCHANNEL HEAT EXCHANGER TECHNOLOGY

## Fluid-to-Air Heat Exchangers in Stationary HVAC Applications

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**Abstract:** Microchannel heat exchangers have a number of advantages over other heat exchanger technologies including high efficiency heat transfer, high reliability and durability, reduced refrigerant charge, and reduced size, weight, and carbon footprint. Johnson Controls microchannel heat exchangers have been carefully designed and tested for the unique conditions of the stationary HVAC application using laboratory and field tests. Optional e-coating provides extra corrosion resistance in severe industrial and other corrosive environments. Proper cleaning techniques are important to assure continued, reliable performance.

Keywords: microchannel, heat exchange, e-coat, corrosion, cleaning

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## 1 INTRODUCTION

Environmental awareness and responsibility have caused us to make more sustainable choices. In the HVAC industry, this means higher efficiency systems that consume less energy and material and reduce carbon dioxide emissions produced by power plants. The industry has moved towards more environmentally friendly refrigerants with lower global warming potential that do not deplete the ozone layer. Engineers are continuously challenged to apply new technologies to meet the need for more sustainable and reliable products. Heat exchangers are a very important component of a high efficiency HVAC system.

Johnson Controls uses microchannel heat exchanger (MCHX) technology to create more sustainable, reliable, environmentally responsible products that deliver high value to our customers. This paper discusses the advantages of MCHX, the specific details of MCHX application, and heat exchanger corrosion resistance.

## 2 HEAT EXCHANGER BASICS

A heat exchanger is a device designed to efficiently transfer thermal energy from one medium to another, typically without being in direct contact. Two of the most common applications of heat exchangers are in automotive and building Heating Ventilation and Air Conditioning (HVAC). Fluid-to-air heat exchangers are generally used in vehicles, residential air conditioning, air-cooled chillers and condensing units. A condenser is a type of fluid-to-air heat exchanger that cools, condenses, and sub-cools refrigerant to reject the heat generated from the vapor compression cycle.

Round Tube Plate Fin (RTPF) heat exchangers have been widely used in the HVAC industry since the early stages of air conditioning. These heat exchangers are available in different materials and designs but the most common is the copper tube, aluminum plate fin type. Most RTPF heat exchangers are constructed with 3/8” copper tubes and aluminum plate fins which are mechanically connected using tube expansion. Variations to RTPF heat exchangers include copper plate fins and aluminum round tubes. Improved construction methods, tube properties and aluminum fin enhancements have evolved in RTPF heat exchangers, but the basic design is unchanged in the past century.

## 3 MCHX HISTORY

Microchannel heat exchangers (MCHXs) were first introduced in the late 1980’s when the automotive industry was transitioning from CFC-12 refrigerant to the more environmentally friendly HFC-134a. As a result of reduced heat transfer properties for HFC-134a, the size of traditionally used RTPF heat exchangers had to be increased to maintain the same performance. The industry however, was looking for heat exchangers with better heat transfer efficiency, smaller size, lighter weight, and better reliability. Microchannel technology was the solution.

Since that time, microchannel technology has become the standard in the automotive industry worldwide and is now being applied in four out of every five vehicles being produced. With its proven performance and reliability, it was inevitable that stationary HVAC would take advantage of the superior performance of MCHXs.

## 4 MCHX DESIGN & CONSTRUCTION

Johnson Controls MCHXs are constructed of parallel flow aluminum alloy tubes metallurgically brazed to enhanced aluminum alloy fins. The proprietary aluminum alloys used in the heat exchangers have been carefully selected and are the outcome of years of laboratory testing, field trials, and thousands of installations in the most severe climate conditions around the globe. The Johnson Controls microchannel is a superior heat exchanger that has been field-proven to meet HVAC industry requirements.

Three basic components are used in the construction of MCHXs as seen in FIGURE 1:

- Parallel Flow Aluminum Alloy Tubes
- Enhanced Aluminum Alloy Fins
- Aluminum Alloy Manifolds

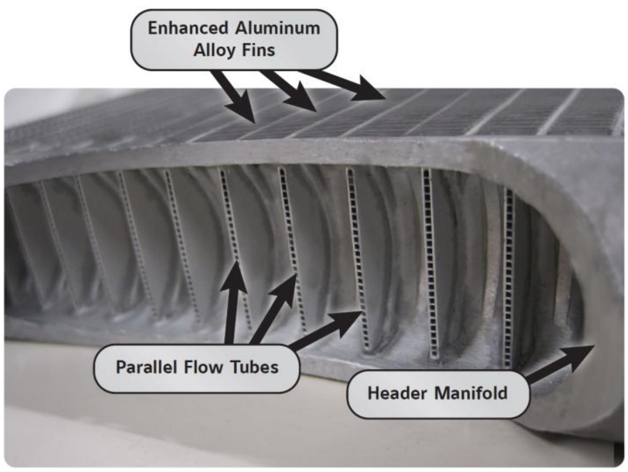


*FIGURE 1 – Cut Away View of Basic Microchannel Heat Exchanger Construction*

Microchannel tubes provide many parallel refrigerant flow paths between the two manifolds. A circuit separator located inside the manifold segments the heat exchanger assembly into two distinct sections; a de-superheating section where the refrigerant gas transitions from gas to liquid, and a sub-cooling section where the liquid refrigerant is further cooled below its saturated temperature. Figure 2 shows a typical MCHX refrigerant flow path.

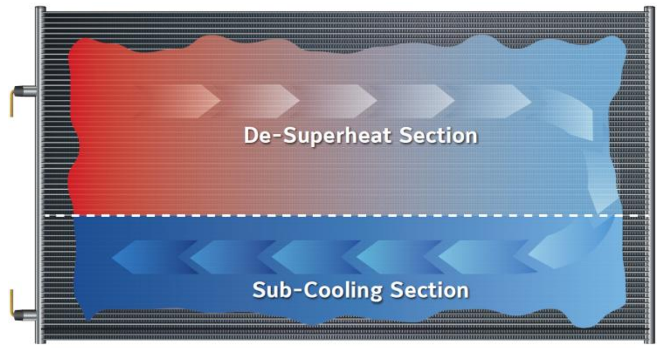


*FIGURE 2 – Typical Microchannel Refrigerant Flow*

## 5 MCHX MANUFACTURING PROCESS

Controlled Atmosphere Brazing (CAB) furnaces are used to manufacture aluminum alloy MCHXs. This precision controlled, nitrogen rich atmosphere process minimizes heat exchanger surface oxidation resulting in clean, consistent braze joints. These braze joints are more consistent than RTPF heat exchangers brazed by hand in ambient conditions.

## 6 MCHX ADVANTAGES

Demand for higher efficiency will continue to increase. Fuel costs and shipping and storage requirements will demand smaller products. Microchannel offers several advantages compared to RTPF heat exchangers.

**MCHX Advantages:**
- Improved Heat Transfer Properties
- Smaller Size, Weight, & Carbon Footprint
- Reduced Refrigerant Charge
- Reduced Pressure Drop
- Easier Cleaning

Heat exchanger capacity is determined by measuring the heat transfer between the refrigerant passing through the heat exchanger tubes and the air moving across the heat exchanger fins. MCHXs improve heat transfer through optimal fin geometry, the use of flat tubes with parallel flow refrigerant paths, metallurgical fin to tube bond, and increased wetted perimeter.

- The louver enhancements found on the MCHX fins are designed to optimize heat transfer by directing and mixing the air flow. A greater percentage of the fin area is louvered in MCHX compared to RTPF.
- The flat tubes found in MCHXs result in reduced aerodynamic drag and reduced air-side pressure drop providing reduced fan power and improved overall energy efficiency.
- Heat conduction is affected by the fin to tube connection. The thermal contact resistance in RTPF heat exchangers results from imperfect mechanical interference between the tube and the fin. MCHXs utilize metallurgical fin to tube brazed connections, eliminating thermal contact resistance and improving heat conduction.
- Refrigerant-side heat transfer occurs at the internal surface area of the tube called the "wetted perimeter." MCHXs use multiple parallel-flow ports in the tubes to greatly increase the wetted perimeter and further enhance heat transfer.

## 6.1 Smaller Size, Weight, & Carbon Footprint

Improved thermal performance results in reduced heat exchanger size and weight. MCHXs can reduce heat exchanger face area up to 40% and heat exchanger weight up to 30% resulting in smaller product size and greater application and handling flexibility. Such size and weight advantages result in secondary benefits of reduced carbon footprint and energy consumption associated with raw material, distribution, shipping and end-of-life recycling and disposal.

## 6.2 Reduced Refrigerant Charge

Reduction in the overall cross sectional area of the tube carrying the refrigerant in addition to the reduced heat exchanger size results in refrigerant charge reduction up to 50%. This allows for lower installation and service costs associated with expensive refrigerant usage.

## 6.3 Reduced Air-Side Pressure Drop

The parallel channels in MCHXs allow for reduced airflow restriction across the tubes when compared to the staggered tube layout in RTPF heat exchangers. In addition, MCHXs are approximately one fourth the depth of RTPF heat exchangers. The parallel tube layout and reduced heat exchanger depth help minimize the restriction of air through the heat exchanger and thus reduce air pressure drop, lower fan power, and overall noise levels (Figure 3).

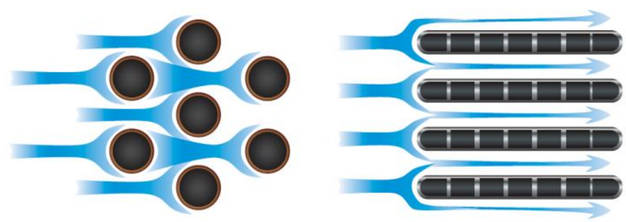

*FIGURE 3 – RTPF vs. MCHX Air Flow*

## 6.4 Easier Cleaning

Regular cleaning is an essential part of maintaining the integrity and heat transfer properties of heat exchangers. The reduced depth and parallel tube layout of MCHXs minimize the restriction of cleaning water through the heat exchanger. This can provide a shorter and more direct path for cleaning water to carry away dirt and debris in MCHXs during regular maintenance. In addition, the simple fin layout in MCHXs makes it possible to use nylon bristle brushes to sweep debris on the heat exchanger face without the use of water.

## 7 CORROSION BASICS

One of the major concerns when applying microchannel heat exchangers to stationary HVAC applications is corrosion. Johnson Controls has done extensive laboratory and field testing to develop material systems that meet the requirements of demanding environments where our customers use our products.

Corrosion is a natural process that seeks to reduce the binding energy in a metal due to chemical reactions with its surroundings. Metal alloys are susceptible to corrosion when exposed to moisture in the air, but the process can be accelerated by exposure to certain substances that may be found in the environment. Corrosion occurs in multiple forms in stationary HVAC applications, but general corrosion and galvanic corrosion are the two most common.

### 7.1 General Corrosion

Also known as atmospheric corrosion, general corrosion is the most common and visible form. Dissolved pollutants in the moisture in the environment from precipitation or condensation can affect the pH levels and create an environment that is more severe than the moisture alone.

Aluminum resistance to general corrosion is high, hence its wide usage in outdoor HVAC applications. The factor that contributes most to the good corrosion resistance of aluminum is its self forming microscopically-thin surface layer of aluminum oxide. The film can vary in thickness depending on the type of aluminum alloy and the age of the heat exchanger. The corrosion resistance of aluminum depends upon this protective oxide film, which is stable in water with pH levels between 4 and 8.5. The oxide film is naturally self-renewing and accidental abrasion or other mechanical damage of the aluminum surface is rapidly repaired.

High concentrations of pollutants in the air change the pH levels. The acidity or alkalinity of the moisture degrades the protective oxide film and minimizes its ability to re-form. The result is a condition that promotes the corrosion of metals.

### 7.2 Galvanic Corrosion

Also called dissimilar metal corrosion, galvanic corrosion occurs when two different metals are in electric contact with each other and bridged with an electrically conducting media. Although the coupled metals may not corrode by themselves, when connected together, the less noble metal becomes the anode and corrodes faster than it would by itself, while the more noble metal becomes the cathode and corrodes at a slower rate than it would alone.

In the HVAC industry, RTPF heat exchangers are usually constructed of copper tubes and aluminum plate fins connected by mechanical tube expansion. A single heat exchanger has thousands of connection points between the copper tubes and the aluminum fins. Each connection becomes susceptible to galvanic corrosion with the presence of moisture. Aluminum being the less noble of the two metals becomes the sacrificial metal and corrodes, whereas alone, it might not have. Figure 4 shows the start of galvanic corrosion on aluminum fins.

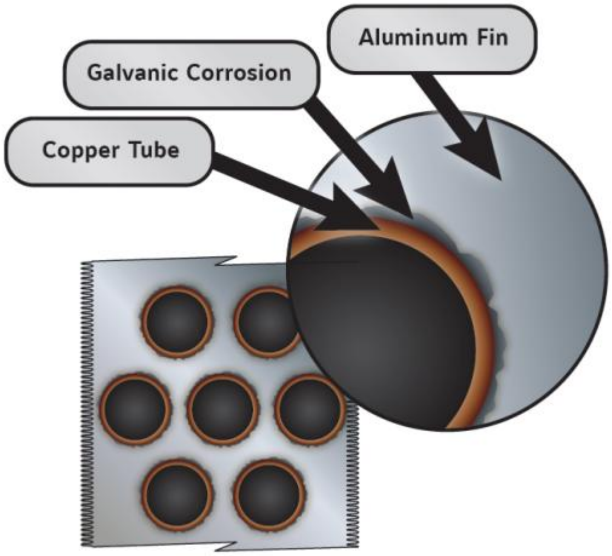


*FIGURE 4 – Galvanic Corrosion between Copper Tubes and Aluminum Fins*

Galvanic corrosion produces corrosion products at the tube and fin interface, reducing heat conduction and causing a drop in the heat exchanger performance. Galvanic corrosion combined with heat exchanger cleaning can eventually cause the fins to break loose from the tubes and disintegrate.

The acidity or alkalinity of water, caused by pollutants in the air, can further accelerate the galvanic corrosion. Corrosion rates rapidly increase as water pH levels drop below 4 or rise above 8.5. This is due to the instability of the protective oxide layer in these pH ranges. A typical weight loss curve for aluminum in Figure 5 illustrates the effect of pH.

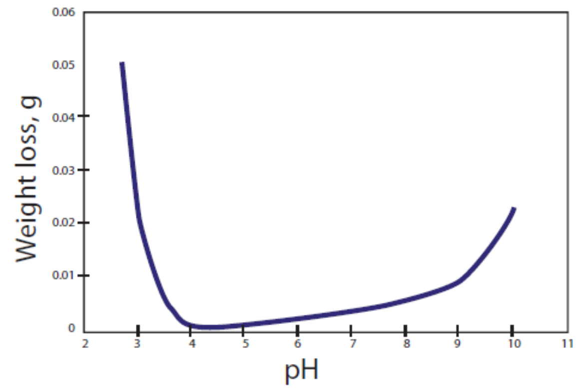


*FIGURE 5 – Weight Loss of Aluminum Alloy at Various pH Values. (Ref -1)*

# 8 MCHX CORROSION CONSIDERATIONS

## 8.1 MCHX Corrosion Resistant Design

Heat exchanger degradation can result from interaction between exposed metal and the surrounding environment such as chloride, sulfur, and nitrate air pollutants. The aluminum alloys used in Johnson Controls' MCHXs have been carefully selected and tested for their corrosion resistance. MCHX tubes contain a zinc-coated surface to provide an additional level of corrosion protection. The zinc diffuses into the aluminum microchannel tubes creating a sacrificial layer and imparting protection against general corrosion in a manner similar to zinc galvanizing on steel. The aluminum fins are manufactured from an alloy that chemically interacts in a way that provides additional corrosion protection for the microchannel tubes. In addition, the aluminum fins are flush and do not extend beyond the tubes, which offers additional protection to the fins in MCHXs. This is especially important in the combination of desert and coastal environments where sand particles may get stuck in fin crevices weakening or damaging the fin protrusions.

## 8.2 MCHX Alloy Selection

The aluminum alloys and material systems used in Johnson Controls MCHXs were specially developed for use in stationary HVAC applications. The heat exchanger consists of aluminum as the base material with various alloying elements added to improve strength, manufacturability, and performance. The aluminum alloys used promote improved protection against corrosion and increase overall MCHX performance and durability.

## 8.3 MCHX Validation

The automotive industry has decades of experience using MCHX technology which provides extensive data in the reliability of MCHX in vehicular applications. However, there are differences in environments and operating conditions between automotive and stationary HVAC applications. These include: air velocity, time of wetness, chemical exposure, and precipitation. These differences can have a significant effect on the corrosiveness of the environment.

Johnson Controls has conducted extensive field and laboratory tests to understand corrosion resistance of MCHX in stationary HVAC applications. Field trials have been conducted at various sites that include highly corrosive seacoast, industrial, and desert environments. These field trials were used to validate the superior corrosion resistance of Johnson Controls proprietary microchannel tube and fin alloys and to develop laboratory tests that simulate the corrosion mechanisms seen in these environments.

The traditional standard test method by which aluminum heat exchanger corrosion has been evaluated is ASTM G85 A3, commonly referred to as SWAAT (Sea Water Acetic Acid Test). Johnson Controls has conducted extensive field tests from which a specific laboratory test based on SWAAT has been developed. This aggressive test predicts improvements in corrosion resistance and replicates corrosion mechanisms seen in the field. This test accelerates corrosion and allows for comparison between various alloy combinations. Johnson Controls uses this test to develop highly corrosion resistant heat exchangers. Johnson Controls has been able to correlate this laboratory test to severe field environments experienced by stationary HVAC equipment. This ability has been critical for developing materials that are optimized to stationary HVAC environments.

## 8.4 Salt Spray Testing versus SWAAT

Since the corrosion failure mechanisms of RTPF and MCHX are different, the same test is not used to compare their relative longevity in the field.

Neutral salt spray testing per ASTM B117 is typically used to qualify the corrosion resistance of RTPF heat exchangers. The neutral salt spray test is useful for evaluating RTPF, where the primary corrosion failure mode is galvanic corrosion of aluminum fins in contact with the more noble copper tubes. The pH is controlled between 6.5 to 7.2, meaning it is essentially neutral (i.e. neither acidic nor basic). Test results are evaluated based on qualitative observation of the appearance of corrosion products (e.g., oxides).

For MCHX, the SWAAT test is preferred to evaluate resistance to corrosion failure in severe corrosive environments. Corrosion failure for MCHX occurs primarily by general corrosion, sometimes in local areas also known as pitting corrosion. Such corrosion occurs in salt water and acidic environments as typically seen along the seacoast and in highly polluted areas. For that reason, SWAAT is performed at a pH between 2.8 to 3.0 which means the solution is acidic. The acidic pH plus the chloride ions in the salt solution can cause localized break down of the protective oxide layer on aluminum and initiate and accelerate pitting corrosion. This simulates MCHX corrosion in the laboratory and can better predict field performance on an accelerated basis, particularly for corrosive environments exhibited by salt water mist or acid rain.

### 8.5 MCHX Surface Appearance

Flux is applied to the clad manifold surface and is designed to braze the manifold to the microchannel tubes. MCHX surface appearance can vary greatly as a result of residual flux and braze cladding flow often seen on the manifold surface. An example of the surface appearance can be seen in Figure 7.

The residual flux layer can result in a whitish surface residue. The surface residue and roughness do not indicate susceptibility to corrosion or likelihood of premature failure. It is preferable to maintain a residual flux layer on the aluminum alloy surfaces. Flux is required to achieve high-quality braze joints and provides additional protection of metal surfaces from exposure to the environment. The flux used in Johnson Controls MCHXs has been carefully selected to help maintain a pH that is more neutral in wet environments.

*FIGURE 7 – Typical MCHX with Visible Flux Residue*

## 9 RTPF ADDITIONAL CORROSION PROTECTION COATING

Any type of heat exchanger used in stationary HVAC applications may require a coating to achieve desired longevity depending on the environment and the heat exchanger materials. Manufacturers offer a number of different options for RTPF heat exchanger protection against corrosion. This section is included for reference to the coating options used with RTPF. RTPF coating options are referred to as pre-coated fin or post-coated heat exchangers. The two most common types of post coated heat exchangers are dip phenolic and e-coat.

### 9.1 Pre-Coated Fin

Pre-coated fin refers to the process where the aluminum plate fins are punched from pre-coated fin stock. The coating provides improved resistance to galvanic corrosion of the aluminum fins, although the cut edges at the fin perimeter, holes and louvers are not protected by the coating.

### 9.2 Post-Coated Heat Exchangers with Dip Phenolics / Elastomerics

Dip and spray coatings using dip phenolics or elastomerics are applied after the heat exchanger is fully assembled to allow protection of all components. The process is usually manual and can result in some inconsistencies and bridging causing a decrease in thermal performance. While coverage is not perfect, these coatings have been used for a number of years, and generally have been recognized as providing effective protection against general and galvanic corrosion in RTPF heat exchangers.

### 9.3 Post-Coated Heat Exchangers with Factory Applied E-coat

This option provides an electro-deposited and baked flexible epoxy polymer coating (e-coat) uniformly applied to all heat exchanger surface areas without material bridging between fins. The coating process ensures complete heat exchanger encapsulation and a uniform dry film thickness on all surface areas including fin edges. Factory applied e-coating offers the best resistance to both general and galvanic corrosion with essentially equivalent thermal performance.

## 10 MCHX E-COAT CORROSION PROTECTION

E-coating provides added corrosion protection for MCHXs. In highly corrosive SWAAT testing, E-coated units were tested twice as long as uncoated heat exchangers with no failures.

There are some extra processing considerations for applying e-coat to MCHX compared to RTPF, but the coating is functionally similar. In the MCHX e-coat process, the heat exchanger is submerged in a water-based coating bath and an electrical current is applied to cause the coating to deposit on the surfaces of the heat exchanger. The main steps of the e-coat process are shown in Figure 8.

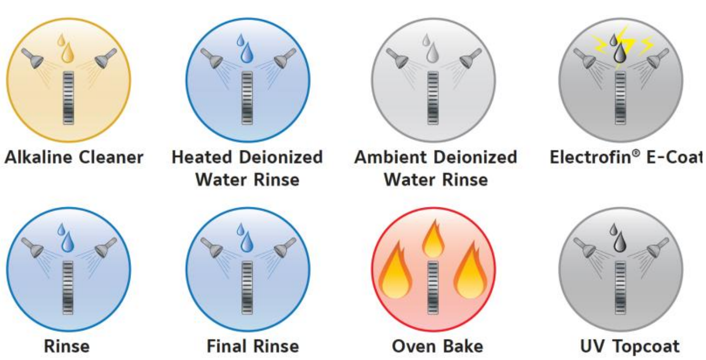


*FIGURE 8 – E-coat Process*

In the e-coat process, the heat exchanger acts like a magnet, electrically attracting the coating molecules to the metallic heat exchanger surfaces. This ensures a complete and uniform coating over the entire heat exchanger exterior surface. The finished coating provides superior resistance to industrial, coastal, and other corrosive environments, and for that reason E-coat is the recommended coating for MCHX.

Johnson Controls does not approve field applied coatings for MCHXs. Field applied coatings are not capable of achieving complete surface coverage, therefore will not provide adequate protection in highly corrosive environments. Field applied coatings may actually accelerate corrosion by concentrating corrosion on uncoated surfaces. The use of field applied coatings for MCHXs may void the Johnson Controls warranty.

## 11 MCHX IN CORROSIVE ENVIRONMENTS: E-COAT APPLICATION GUIDE

In all HVAC applications, product location must be considered based on proximity to known corrosive environments. For severe corrosive environments, the Johnson Controls factory applied e-coat is recommended to provide extended MCHX service life. The description of several corrosive environments and e-coat application guide for MCHX are described in the next sections.

### 11.1 Industrial Environments

Industrial atmospheres are usually characterized by pollution directly emitted from human-made processes that are composed mainly of sulfur dioxide ($SO_2$) and nitrogen dioxide ($NO_2$).

Sulfur dioxide and nitrogen dioxide are produced from burning fuels such as coal and petroleum, mainly in thermal power plants and in the production of paper and the smelting of metals. Further oxidation of $SO_2$, usually in the presence of a catalyst such as $NO_2$, forms sulfuric acid ($H_2SO_4$) which settles in microscopic droplets and falls as acid rain. This can form a highly corrosive acidic film on exposed surfaces.

For severe industrial environments, e-coating of the MCHX is recommended. E-coating is recommended for installations with exposure to low pH (especially less than pH 4) acid rain which contains high levels of sulfuric and/or nitric acid. High amounts of particulate dust deposits on exposed heat exchangers may make the environment even more severe, especially if the dust contains industrial dust emissions from burning of coal or other fossil fuels, which usually contain high levels of corrosive iron and sulfur compounds.

### 11.2 Coastal Environments

Coastal environments contain sea water mist carried by wind that potentially settles on exposed surfaces depositing salt crystals. The quantity of salt deposits can vary greatly with wind velocity and in extreme conditions may form a highly corrosive layer of salt.

When high levels of chloride ions (i.e. salt) exist in the environment, the protective oxide film of the metal can be compromised, leaving exposed areas that can promote rapid advancement of corrosion. Salt deposits also get mixed with moisture in the form of rain or condensate increasing its electric conductivity, which has a direct impact on the rates of galvanic corrosion. Salt contamination decreases with distance from saltwater bodies and are greatly affected by wind currents.

The improved corrosion resistant aluminum alloys used in Johnson Controls MCHX provide excellent resistance to chloride corrosion. However, for installations very near the sea coast, especially in warmer climates, the Johnson Controls factory applied e-coating may be optionally chosen to provide extended MCHX service life.

E-coating should be especially considered for installations in industrial environments within 5 miles (8 km) of the seacoast and/or if the unit is exposed to sea breezes which can deposit salt water mist on the heat exchanger surfaces.

Coastal desert environments are often composed of sand that is blown by wind. Sand alone does not contribute to corrosion, but when combined with sea water mist, sand particles stuck in crevices may lock in moisture and concentrate corrosion. For coastal desert environments where dust accumulation is expected and the MCHX is exposed to high levels of sea mist, the Johnson Controls factory applied e-coating may be optionally chosen to provide extended MCHX service life.

### 11.3 Other Corrosive Environments

Several other environments may produce corrosive conditions for which the Johnson Controls factory-applied e-coat will extend service life. Those should be considered on a case-by-case basis:

- If the installation location is in an area where there is or will be extensive road and building construction, which can generate high pH (greater than pH 9) cement dust and metal particles that can deposit on the heat exchanger surfaces.
- If the installation location includes agricultural operations. Agricultural operations often produce high pH (greater than pH 9) corrosive chemicals from ammonia fertilizers and animal waste.
- If the installation location is at ground level where the MCHX can be directly splashed with deicing salts used for snow and ice removal.

- If the installation is in the vicinity of a building exhaust outlet from facilities containing corrosive gases.
- If there is evidence of severe corrosion damage to existing equipment or structures at the installation location, even if none of the corrosive conditions previously listed are evident.

The corrosiveness of any environment will be more severe as time of wetness increases, such as in high precipitation and humidity areas, especially tropical climates. Tropical climates are distinctively characterized by high temperatures and relative humidity during the day and long periods of condensation during the night. These conditions yield high temperatures and higher than usual condensation levels for long periods of time throughout the year. This may produce a highly corrosive environment on MCHX surfaces, for which the Johnson Controls factory-applied e-coat will extend service life.

## 12 CLEANING

Cleaning of heat exchanger surfaces may be required to maintain proper operation of the unit. The following cleaning procedures are recommended when cleaning is required. Refer to the product instruction and/or service manual for more details. Failure to follow product cleaning guidelines can result in heat exchanger damage, including leaks or loss of performance.

- Johnson Controls recommends use of clean, potable water to clean MCHX. Johnson Controls does not permit the use of chemical cleaners to clean MCHXs. Clean, potable water is the most suitable cleaning agent. City tap water is recommended.
- Remove surface debris such as dirt, leaves, insects, fibers, etc. with a vacuum cleaner having a soft attachment rather than a metal tube. Compressed air blown from the inside out can also be used. When brushing debris off the face of the heat exchanger, a soft bristle (not wire) brush can be used. Do not contact the heat exchanger with the vacuum nozzle, air nozzle, or any other tool.
- Water pressure for cleaning should not exceed 100 PSI (7 bars), typical of a spray from a common garden hose with attached nozzle. Pressure washers should not be used as they can significantly increase water pressure and damage the heat exchanger. The cleaning should be from the inside out to drive fibers and dirt out of the heat exchanger.

## 13 REMOVAL AND REPLACEMENT

MCHX leaks are relatively rare and are typically caused by mechanical damage. It is important that proper diagnostics tools are used to determine the source of leaks. Heat exchangers are sometimes mistakenly identified as leaking, then removed and replaced. Often, this is due to low refrigerant charge which negatively affects system performance. Such conditions may result from insufficient charge or a leak elsewhere in the system.

Another reason for incorrectly identifying a leak in MCHX is discoloration or a stain on the heat exchanger. Such a stain may appear to be refrigerant oil emitted due to a leak; however, this is often not the case. Sometimes refrigerant oil can be deposited on a MCHX from a leak elsewhere in the system. Stains can appear from contaminants in the environment.

To properly diagnose the location of a leak, use an electronic leak detector or soap bubbles to confirm a leak is present in the MCHX before replacement.

Care should be taken to avoid damaging the microchannel tubes. If a leak due to mechanical damage is found in the MC heat exchanger, Johnson Controls offers a field repair kit for MCHXs. Follow the instructions provided with the repair kit.

Replacing heat exchangers requires opening the refrigeration system, which requires proper practices and skilled technicians. Proper practices include: removing and weighing refrigerant charge, cutting the connection at the copper side, installing the new heat exchanger using a nitrogen charge to keep the system clean while brazing, replacing filter/dryer, maintaining 500 micron vacuum for 10 minutes (minimum) to ensure system integrity, then gradually introducing the proper refrigerant charge on the high pressure side of the system.

It is important to accurately weigh in refrigerant charge to specified name plate and charge adders as documented in the product technical literature. The system should then be operated for 15 minutes to ensure pressures, sub-cooling, and superheat readings are within expected ranges. Based on these parameters, minor adjustments in charge amounts may be appropriate. Please refer to the product technical literature for more information about replacement of MCHXs in the field.

Johnson Controls MCHXs are equipped with transition joints with copper connections. Do not attempt to braze copper to aluminum, as this braze process requires process controls beyond typical equipment capabilities available in the field. When brazing the copper connection joints to the unit copper tubing, use a wet cloth around the aluminum tube at the transition joint to keep heat away from the aluminum tubing and keep all surfaces clean to avoid potential corrosive contaminants from coming in contact with aluminum surfaces.

## 14 SHIPPING, STORAGE AND COMMISSIONING

All HVAC equipment containing air-side heat exchangers must be properly packaged for shipment to reduce environmental exposure to road dirt and salts such as calcium chloride and other de-icing organic or inorganic chemicals. Most Johnson Controls equipment is properly packaged in shipping bags or containers for improved protection during transit. Exposed equipment without adequate packaging can experience damage due to corrosion and should be cleaned thoroughly using approved cleaning methods prior to unit operation

It is a best practice to make sure all HVAC equipment is thoroughly inspected before placement in storage. The equipment must be stored in an area where construction activity is minimal. Equipment storage location should avoid exposure to concrete dust, industrial contaminants, construction debris, and exhaust from vents or similar harmful elements. For proper installation practices, product limitations and recommended product protection instructions refer to the product installation and operation manual.

Should product installation require piping connections, care must be taken to prevent metal shavings such as iron, steel or copper from contacting the heat exchanger surface. Metal particles may result in accelerated corrosion and premature heat exchanger failure.

## 15 SUMMARY

Microchannel heat exchangers have immense advantages that make the technology an excellent fit for the HVAC industry. The high efficiency, reliability, reduced refrigerant charge, and reduced size, weight, and carbon footprint are all reasons making microchannel a good choice in fluid-to-air heat exchangers. An understanding of the environment where the heat exchanger will be installed is essential to ensure its longevity. Johnson Controls MCHXs use specially developed materials to help ensure high reliability and corrosion resistance, and have been carefully designed and tested for the unique conditions of the HVAC stationary application.

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