Microchannel Heat Exchangers – Quick Facts

Background

Microchannel heat exchangers were first applied in the automotive industry in the late 1980's, driven primarily by the need to switch from CFC-12 to HFC-134a. Other drivers like weight, dimensions, and refrigerant charge contributed to the design of microchannel.

Microchannel technology proved successful in automobiles which experience extreme vibrations from the engine and road conditions, high impact from debris, chemicals from road salt, de-icers, and oils, air contaminants and pollutants, and extreme temperatures. Four out of five automobiles on the road today have microchannel heat exchangers.

Stationary HVAC vs. Automotive Applications

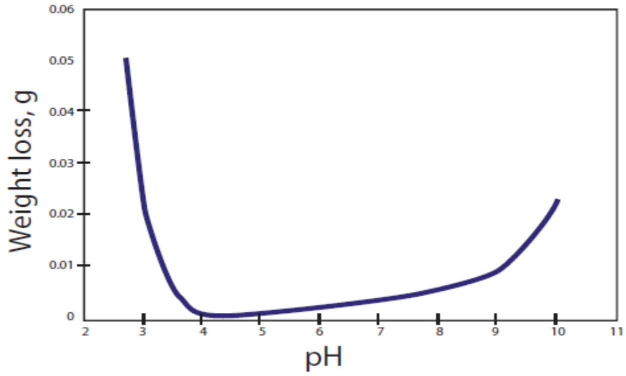
The great reliability in automotive applications gave HVAC manufacturers confidence to incorporate the technology into stationary equipment with the assumption that the heat exchangers would experience less extreme conditions than those present in automobiles, however that didn't turn out to be the case.

Early installations highlighted key application differences, with important implications, between stationary HVAC and those in automobiles:

- Stationary HVAC heat exchangers are wet much longer than automotive applications
  - Automotive coils have high face velocity that helps remove moisture
  - Automotive applications stay warm/hot under the hood causing moisture to evaporate
  - Automotive coils stay shielded from precipitation
- Stationary HVAC applications are seasonal and remain exposed to outdoor conditions, but are non-operational for several months during the year

Early generation microchannel heat exchangers applied the same braze flux material used in automotive applications. The braze flux created high pH conditions when exposed to moisture for extended time periods. The high pH created a corrosive environment that directly attacked the aluminum.

The automotive-designed microchannel heat exchangers had



***Graph 1**, Weight loss due to corrosion plotted by pH*

relatively thin tube wall thicknesses designed for low weight and better automobile fuel economy. They also used lower grade aluminum alloys to hit aggressive cost targets needed in the automobile industry.

Less corrosion-resistant alloys and thinner wall tubes increased opportunity for tube failure, especially in coastal and industrial climates.

Johnson Controls Microchannel Heat Exchangers

Johnson Controls created a Center of Excellence in Engineering (COEE) that focused entirely on heat exchanger technology and microchannels. The team consisted of PhDs in materials and heat transfer engineering. The COEE set standards and performance requirements for microchannel, specified tube alloy materials, wall thickness, fin alloy material, and braze flux material. The expert team inspected, approved and audited heat exchanger production facilities and conducted extensive, on-going testing of heat exchanger technologies and production samples.

Johnson Controls has been shipping YLAA chillers with microchannels since 2007 and YVAA chillers since 2010, with more than 50,000 microchannel heat exchanger installed worldwide. The field installations have proven the high reliability of the Johnson Controls microchannel design.

Graph 2, Johnson Controls microchannel installation sites by location in the U.S., concentrated around coastal and industrial cities

Johnson Controls Microchannel Testing

Johnson Controls COEE used four methods to evaluate accelerated corrosion:

- ASTM G85-A4 (Salt + SO2)
    - Salt, sulfur dioxide gas, pH ~2.8-3.0 (Typical pollutant from coal and oil power plants)
- ASTM G85-A3 (SWAAT)
- Sea salt, acetic acid, pH ~2.5-3.0 (Common test for aluminum corrosion)
- Severe coastal, high chloride site testing
- Severe pollution and coastal site testing

The Sea Water Acetic Acid Test (SWAAT), ASTM G85-A3, is the industry standard test used for validating aluminum heat exchangers. The test is a cyclic fogging test with pH of 3 that's a modification of the ASTM B117 Salt Spray (Fog) Testing.

The team also performed extensive field testing in locations around the world that resulted in the extremely high confidence Johnson Controls' has in our products and microchannel heat exchangers.

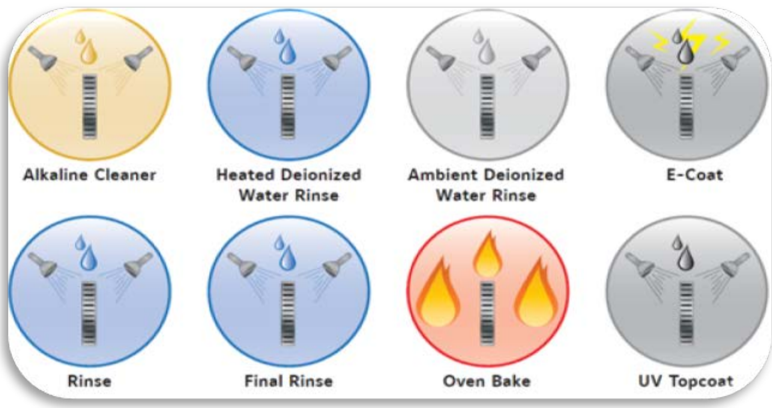
Graph 3, *Left:* *Tianjin, China (identified as city with top 10 worst air pollution). Right: New Smyma Beach, FL (Severe subtropical marine environment, category C4/C5 corrosive environment (ISO 9223)*

Optional Microchannel Coating

Optional microchannel coating 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. Johnson Controls factory-applied e-coating offers the best resistance to corrosion for microchannel heat exchangers.

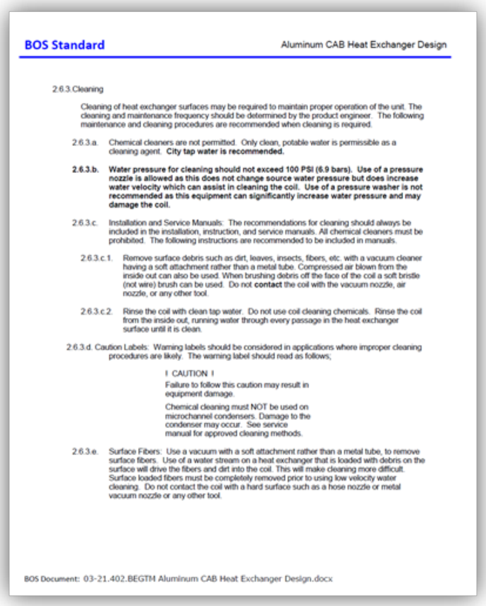
E-coating is recommended for the most aggressive corrosion applications such as:

- Industrial: Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2) pollution; low pH acid rain (sulfuric or nitric acid); heavy dust (fossil fuel burn – iron & sulfur)
- Coastal: within 5 miles (8 km) of coast, or in prevailing wind (chloride)
- Other: High pH (pH>9) from cement dust, Agricultural operations



***Graph 4**, e-coat process*

Microchannel Cleaning Requirements



BOS Standard Aluminum CAB Heat Exchanger Design

2.6.3.Cleaning

Cleaning of heat exchanger surfaces may be required to maintain proper operation of the unit. The cleaning and maintenance frequency should be determined by the product engineer. The following maintenance and cleaning procedures are recommended when cleaning is required.

2.6.3.a. Chemical cleaners are not permitted. Only clean, potable water is permissible as a cleaning agent. **City tap water is recommended.**

2.6.3.b. Water pressure for cleaning should not exceed 100 PSI (6.9 bars). Use of a pressure nozzle is allowed as this does not change source water pressure but does increase water velocity which can assist in cleaning the coil. Use of a pressure washer is not recommended as this equipment can significantly increase water pressure and may damage the coil.

2.6.3.c. Installation and Service Manuals: The recommendations for cleaning should always be included in the installation, instruction, and service manuals. All chemical cleaners must be prohibited. The following instructions are recommended to be included in manuals.

2.6.3.c.1. 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 coil a soft bristle (not wire) brush can be used. Do not **contact** the coil with the vacuum nozzle, air nozzle, or any other tool.

2.6.3.c.2. Rinse the coil with clean tap water. Do not use coil cleaning chemicals. Rinse the coil from the inside out, running water through every passage in the heat exchanger surface until it is clean.

2.6.3.d. Caution Labels: Warning labels should be considered in applications where improper cleaning procedures are likely. The warning label should read as follows;

! CAUTION !

Failure to follow this caution may result in equipment damage.

Chemical cleaning must NOT be used on microchannel condensers. Damage to the condenser may occur. See service manual for approved cleaning methods.

2.6.3.e. Surface Fibers: Use a vacuum with a soft attachment rather than a metal tube, to remove surface fibers. Use of a water stream on a heat exchanger that is loaded with debris on the surface will drive the fibers and dirt into the coil. This will make cleaning more difficult. Surface loaded fibers must be completely removed prior to using low velocity water cleaning. Do not contact the coil with a hard surface such as a hose nozzle or metal vacuum nozzle or any other tool.

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***Graph 5**, BOS Standard describing cleaning requirements*

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:

- Surface fibers, leaves, etc. should be vacuumed with a soft attachment (non-metallic) or blown out with compressed air
- Coils can be cleaned with potable water. Cleaning agents should never be used as they can cause damage to the heat exchanger.
- Maximum water pressure for cleaning is 100 psi. Pressure washers should not be used as they can damage the heat exchanger.

- If brushing coils, a soft bristle, non-metallic brush must be used.

Conclusion

Microchannel heat exchangers have immense advantages that make the technology an excellent fit for stationary HVAC equipment. The high efficiency, reliability, reduced refrigerant charge, and reduced size, weight, and carbon footprint are all reasons making microchannel a good choice for chiller condensers.

Johnson Controls' research and development investment has been significant for more than 10 years in heat exchanger and microchannel technology.
Johnson Controls microchannels 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. Our microchannel heat exchangers have lab and field proven reliability for stationary HVAC applications around the world in various climate types and corrosion levels.

Heat exchanger e-coating is advised for more corrosive environments, especially industrial and coastal locations where traditional copper/copper coils have been typically used.

For additional information refer to the white paper on microchannel heat exchanger technology, BOS 03-01.801.EGTM v2.