GENERIC SURFACE COATINGS for HVAC/R

History: For the past 25 years HVAC/R OEM and Contractor Installers have been applying various coatings/paints on HVAC condenser fins and coils to prevent corrosion. These traditional “paints” serve as thick barriers in an attempt to block salt ions that would accelerate the corrosion resistance process of aluminum and copper fins and coils.

Present: Within the past 8 years a clear, cross-link cured siloxane coating, which is installed at ultra-thin, micron film thicknesses was introduced into the market. How does this new and patented technology differ from the more traditional paints and coatings previously available and how can the HVAC/R design engineer, as well as the owner and operator of the asset, make the most informed decision concerning the preservation of the HVAC asset by means of a protective coating?

The following broad curing mechanism classifications provide an overview of common generic types of organic paint coatings, by curing mechanism that may be encountered in the field.

Cross-link or Chemical Reaction Cured:

1. Polyamide Epoxy
2. Polyester Epoxy
3. Amine Adduct Epoxy
4. Acrylic Epoxy
5. Coal Tar Epoxy
6. Acrylic Aliphatic Urethane
7. Polyester Aliphatic Urethane
8. Moisture Cured Urethane
9. Low VOC H_20 Based Urethanes

These coatings will typically be found in industrial maintenance facilities on tanks, floors or equipment. These coatings are notable for excellent chemical, abrasion and water resistant properties on floors and corrosion resistance on ferrous metals. This broad classification group of coatings generally exhibits high gloss or semi-gloss films and become extremely hard and tight, when cured. They are multiple component materials and must be mixed. They are typically low temperature sensitive and will generally not cure at temperatures much below 50^0 F. The typical full curing of these films will occur in about 7 to 10 days at ambient temperatures between 60^0 and 90^0 F. Faster at higher temperatures; slower at lower temperatures. Also, many epoxy coatings, when exposed to ultra-violet light (exterior) will severely chalk and turn yellow.

Coalescing Cured:

1. Acrylic Latex
2. Vinyl Latex
3. Polyvinyl Acetate Latex
4. Acrylic/Vinyl Latex Blends
5. Other blended polymers

This group broadly encompasses the range of latex films.

These coatings are generally water thinned. The coalescing curing mechanism, simply stated, is a “melting” process of the polymer molecules into each other in order to create a continuous film. Latexes will dry to touch in about 30 minutes, but take about 8 to 10 days to reach full cure; longer at low temperature. This group will typically not cure at temperatures below 45^0 F. These coatings can be formulated with many co-solvents, which help promote the coalescing cure film formation, as well as solvents that help with freeze/thaw stability, pigment acceptance and flow and leveling properties. These co-solvents take several days to evacuate out of a freshly installed film; long after the coating has dried to touch. This group can exhibit gloss ranges from high gloss to matte flat. Except for a few high-end acrylic polymers used in DTM Industrial Finishes, most of these polymer blends will exhibit poor adhesion over non-ferrous metal substrates and very poor wet adhesion characteristics over any substrate. In addition, most of these polymer types will exhibit very poor heat resistance properties.

Solvent Evaporation Cured:

1. Chlorinated Rubber
2. Solution Acrylics
3. Shellac (pigmented or clear)
4. Many lacquer groups

This broad group of coatings cures by solvent evacuation. Simply stated, when the carrying solvents in the coating evaporate out of the film, they are fully cured. The carrying solvents are generally low flash point, fast evaporating solvents such as xylene, toluene, MEK, MIBK, naphtha derivatives, glycol ethers, alcohol, etc; Many times the carrying solvents can be blends of the above listed solvents, or others not listed. These are typically very fast curing products, because once the solvent is gone, they are cured. The problem with solvent evaporation cured coatings is they are always solvent sensitive. Even if these films have cured for years, reintroducing many solvents onto the film can cause the coating to become resoluble, reverting back to a liquid state. Again, this group can range from high gloss to low sheen finishes. They can cure at temperatures down to 35^0 F. The formed films are typically very brittle.

Oxidation or Conversion Cured:

1. Oil Based Paints (linseed)
2. Alkyd Based (soya & other oils)
3. Alkyd/Urethane Blends
4. Phenolic Groups
5. Epoxy Esters

6. Silicone Alkyds
7. Acrylic/Alkyd Blends

This is a very broad group of oil-based products. The oils can be extractions from soybeans, flax, fish or petroleum bi-products. The extracted oils are then processed & reacted with acids or rosins to produce any number of desired molecule chains. When formulated into a finished product, these oil chains are further reacted by the introduction of oxygen and any number of other metallic salt driers or catalysts in order to dry and cure the film. These coatings will reach 95% of full cure in about 10 to 14 days and then will continue to harden until they eventually just crack and crumble apart. They truly never stop curing. The older the film becomes, the more brittle it becomes. These coatings can range from high gloss to matte flat. These coatings exhibit very poor mold and mildew resistance and marginal long-term adhesion over non-ferrous metal surfaces.

Catalyzed Siloxane Coatings: These are inorganic film formers that adhere by both London Force and Covalent Bond methods to bare non-ferrous metal surfaces. The dry film formation is between 5 to 8 microns, which is sufficient to provide an effective barrier against corrosion causing ions. In contrast to mor porous paints, the cross-link cured siloxane film reduces resistance of both air and liquid flow. The ultra-thin deposit enables the film to have negligible impact on heat transfer efficiencies. The nano-sized molecule chain and a specific gravity less than water enables the film to seek out the small micro-indices of non-ferrous metals and the coil/fin joints without bridging build-up between fins, which is highly common when installing traditional paints and coatings. Curing time for water resistance is 2 to 4 hours at ambient temperatures between 70^{0} F and 100^{0} F. The fully cured film exhibits a slight positive charge, which is very hydrophobic and oil-phobic, thereby providing the surface a natural repelling action that keeps the coil cleaner. The inorganic characteristic of the cured siloxane film provides no food source for mold and mildew and the inert quality of the inorganic film will not break down or yellow when exposed to UV degradation.

A general comparison chart for siloxane coatings versus paints is presented below. This is a general information chart, only, and not inclusive of every technology.

Corrosion Protection & Extension of Operating Life!

Feature/Benefit	**MicroGuard® Protections**	**Conventional Coatings**
Corrosion Protection	Yes	Yes
Dry Film Thickness – impacting heat transfer	5 to 8 Microns DFT (25.4 microns = 1 mil).	2 to 6 Mils DFT
Heat Transfer Efficiency	No Impact.	Loss of 5% to 15%.
Warrantable Program	5 Year Limited Warranty – No Extra Charge	Limited Warranty can be obtained for a fee or no Warranty offered.
Adhesion Failure Potential	No, due to its Chemical Bond.	High potential for delaminating, due to a weaker mechanical bond. Can clog fin channels causing poor air flow.
UV & Heat Resistance	Yes – high resistance. Inert to UV >600° F.	UV exposure causes oxidation. Heat may break down coating.
Installation Cost Estimate	8% to 10% of new unit cost. May be installed in the field.	10% to 12% of new unit cost, plus freight costs from factory to coating center and then to installation site.
Replacement Cycle	Deferred capital expenditure due to longer operation life.	Deferred capital expenditure due to longer operation life.

Energy Savings

Feature/Benefit	**MicroGuard® Protection**	**Traditional Coatings**
Energy Consumption	**-5% to -15% Reduction.**	+4% to +10% Increase.
Laminar Flow Impact	**Increases Air Flow up to 10%.**	Reduces Air Flow up to 10%.
Hidden Energy Costs	**None**	Must specify larger condenser coil to compensate for heat transfer loss.

Cleanability

Function/Benefit	MicroGuard® Protection	Conventional Coatings
Film Hardness – Ablative Wear by ASTM D 4060 Taber Abrasion Test	**12.5 mg/loss @ 1,000 cycles (CS-10 Wheel)**	40 to 120 mg/loss – depending on generic type of competitive coating.
Hydrophobic Characteristic	**Very Hydrophobic.**	Moderately Hydrophobic.
Cleaning Requirement	**Mild, non-aggressive cleaners.**	Harsher coil cleaners.
Labor & Material Cost Savings - Cleaning	**25% to 50% (Field Average)**	None – Coatings are harder to clean than bare metal surface.

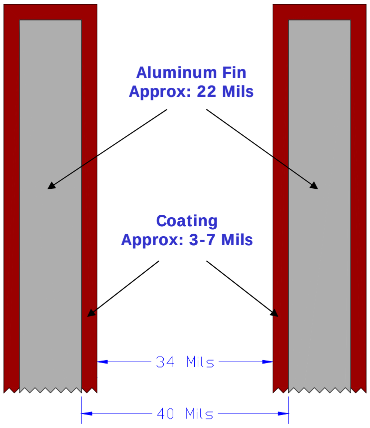
Mold & Mildew Growth

Feature/Benefit	MicroGuard® Protection	Conventional Coatings
Mold & Mildew Growth Testing by ASTM G21	**Zero Growth – will not support growth.**	May support growth.
Mold Protection	**Inorganic Film – no food source.**	Organic Film – potential food source.

Conventional Coatings

- Airflow passage is reduced by approximately 15-35% (higher when more FPI).
  - Pressure drop across the coil increases.
  - Hydrodynamic drag increases.
  - Higher fan power consumption.
  - Reduced air flow through the coil increases refrigerant pressure.
  - Heat Transfer is reduced.

Coil on illustration is 16 FPI



Siloxane Coating

- Airflow passage is not reduced.
  - Pressure drop across the coil decreases.
  - Aerodynamic drag is reduced by 25%.
  - Lower fan power consumption.
  - Heat Transfer is enhanced.

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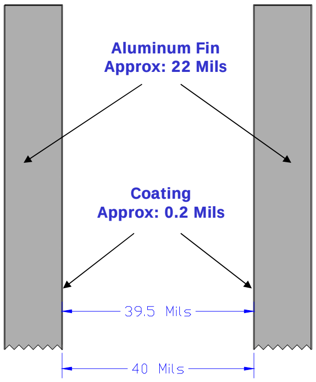
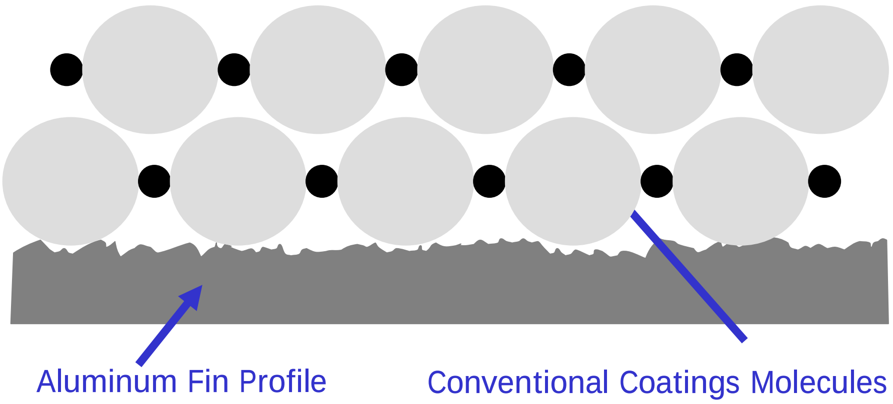


Surface Profile – Conventional Coatings



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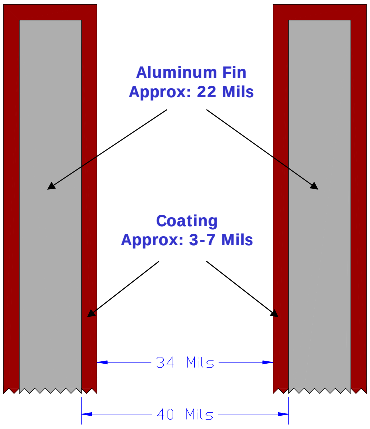

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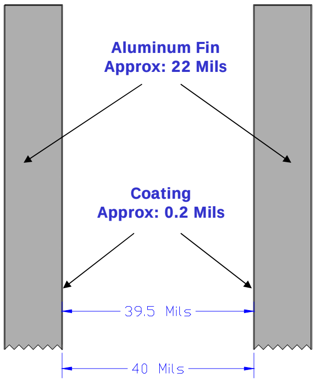

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