Formicary corrosion in a coil

HVAC in Corrosive Environment

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Part 3

Introduction

In Part 2 of this article, published in the January-March 2017 issue of the *Journal*, we learnt how corrosion affects modern HVAC units. In Part 3 of the article, we shall learn about coil coatings.

When a metal or alloy destructs through chemical, physical and electromechanical reaction with the environment, it is known as corrosion. HVAC equipment are increasingly facing corrosive elements all over the country, resulting in loss of coil life, gas leaks from brazing joints, increased maintenance and replacement cost. Aluminium plus copper coils and plain aluminium micro-channel coils are susceptible to corrosive attack due to oxidation and reaction to flux material used in the manufacturing process. Sometimes copper coils are made from re-cycled copper that has impurities, and are easily attacked by corrosive elements. HVAC engineers try to increase coil efficiency through increased coil area by designing more fins per inch; thus solid fins have given way to thin fins. Grooved fins further increase air flow. Nowadays, fins are wafer thin and more prone to corrosive attacks. Copper tubes, as explained in Part 2, have grooving inside and outside, resulting in thinner walls. Recycled copper makes matters worse.

In a coastal salt laden environment, aluminium fins deteriorate in the first 30 days. Grayish salt deposits on the surface of fin stock. This indicates that oxidation process has started – this is the beginning of fin embrittlement. As this process continues, heat transfer capacity of fin stock reduces, thereby increasing operating costs. Up to 55% loss of efficiency can be noted in the first two years, resulting in compressor over-working, tripping and ultimate failure. In an example quoted in Part 1 of this article, fins had swollen up with no loss of strength but a severe reduction in heat transfer. This resulted in compressor tripping and failure.

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About the Author

Mahesh Mehta entered HVAC industry accidentally, being a Textile Engineer. He started by marketing eco-friendly non-toxic imported chemicals in Western India in 1999, conforming to standards like RoHS and MIL. He then began executing turnkey orders for coil cleaning in industrial AC plants with specialized equipment, using a combination of mechanical and chemical cleaning. He has worked with multinationals and Indian companies in pharmaceutical, food, hotel and IT industries for deep coil cleaning, descaling, fin coating, environmental corrosion control, power saving, etc. He likes to work at challenging sites.

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Coil Coatings

Air is increasingly becoming more corrosive due to several environmental, industrial and coastal factors. Corrosion treatment should not be seen as an extra cost. Ignoring corrosive forces will badly affect equipment performance, increase maintenance cost and shorten its life. Sometimes OEMs, despite knowing the consequences, do not quote for the cost of anti-corrosive coating so as to keep their price low.

Various coatings are available in the market, creating confusion in the mind. Even OEMs offer imported units with coating done in various countries. A coating successful in another country may not suit Indian conditions. The Indian summer witnesses temperatures going above 50-56°C. Such excessive temperatures are unimaginable by European and American standards. Several sites with coils having epoxy and other coatings have failed due to various reasons, prominent among them being the lack of UV stability, full pH range protection, and coating without elongation. These three factors are most important while selecting a professional coating. *Table 1* gives, at a glance, various alternative protective solutions with their advantages and disadvantages. The user must always ask for more features that will help extend unit life and efficiency.

Untreated coil in saline environment

Professional treated coil in same environment

Frequently Asked Questions

Q.1: How long can coil life be extended by coating?

A: With proper maintenance and coil cleaning (at least 4-6 times a year), professional coating should outlast the coil. Usually 3-4 times higher coil life can be expected compared to an un-coated coil. So, if un-coated coil has a life of 16-24 months, one can expect a life of 4- 6 years with professional coating combined with an effective maintenance program. During the extended coil life, it will perform with consistent efficiency unlike the steep downgrading seen in an un-coated coil. Such a coil can pay back its cost through power savings in 12-24 months.

Q. 2: Why do I find frequent gas leaks from the condenser coil?

A: This problem exists widely in Industrial, residential and commercial areas. Generally, it is due to un-treated sewer line passing nearby, releasing sulphur, chlorine, acidic fumes, etc. Near industrial zones, effluent treatment plants, paper mills, etc. even at distance up to 10 km, medium to heavy leaks can be found.

Ensure that the coating is resistant to 1-14 pH fumes, and has 200-400% elongation. (As the copper tube heats up, it elongates, so the coating has to elongate correspondingly, or it will fail within 3-12 months.) Epoxy coating, very widely used in India as a low cost alternative, is rigid, has poor UV stability, poor acid resistance and a low life. Such low cost alternatives are difficult to remove later when a new coating has to be re-applied; removal cost is more than the coating cost itself. It is quite difficult to remove it from headers, U-bends and fins. In such cases, coil replacement is the only option. A few professional coatings have the easy removal feature.

Q.3: Can coating reduce heat transfer?

A: Coatings applied to condenser or cooling coil may or may not affect heat transfer, depending on coating film thickness. Certain nanoparticle based coatings have a film thickness of 6-8 micron/coat, whereas certain other coatings have 25-50 micron/coat. The coil being a three-dimensional structure, it is advisable to spray from both sides for an even coating. If the final coating thickness exceeds 40 micron, it will affect heat transfer. Hence, always consider such technical issues while selecting a coil coating.

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Table 1: Comparison of different types of coatings

Copper/ Copper Coil	Pre-coated Aluminum Fin Stock	Phenolic/Epoxy Coil	Water-based Epoxy E-coated coil	All Weather Professional Coating
		Advantages		
Effective thermal performance. Since coil does not have bi-metal construction, galvanic corrosion risk is reduced.	No delay in production. Mild protection. Good thermal efficiency. Coil light weight as compared to copper/copper coil.	Complete coating protection from 3 to 12* pH. Good corrosion protection in mild acidic environment. Major epoxy products have poor UV stability and fin coating affects ΔT. Imported OEM coating is not suitable for Indian conditions.	Complete corrosion protection from 3 to 12* pH, or mild to heavy corrosive atmosphere. Good adhesion and thermal efficiency. Turnover time good.	Excellent thermal efficiency. 100% coating coverage. Excellent corrosion protection from 1 to 14 pH* including severe atmosphere. Due to elongation, it expands, contracts, stretches, and flexes along with coil metal, preventing cracking, flaking and chipping. Field repairable, does not support combustion, has 200-400% elongation. Long life, saves gas leaks.
		Disadvantages		
Cost increases 10 fold. Customised production delays fast delivery. Coil weight increases. Turns brittle when exposed to salt and chlorides. Efficiency lost as it develops patinas.	Exposed edges. Tends to flake. Limited corrosion protection. Not field repairable. Loses operating efficiency from corrosion in 12-18 months.	Rigid, brittle, tends to crack and flake, no elongation. Moderate corrosion protection in severe corrosive atmosphere. Not field repairable. Needs curing after application at high temperature. Coating at fin edges is thin. Low life.	Water based, needs curing at high temperature. Limited corrosion protection in heavy corrosive atmosphere. Field damages are not repairable.	Initial cost higher but, lower on yearly basis. Offers 5-7 years coating life.

**Fume attack-resistance, estimated. Please note this is fume resistivity, not corrosive dipping resistivity, as such standards will badly damage heat transfer.*

Another important issue in HVAC equipment is longevity, which is dependent on the cleaning and maintenance program. Several instances can be cited at premium client sites where, despite proper coating, the desired efficiency and longevity had not been achieved due to a poor maintenance program. At a site located in a corrosive belt, cleaning and maintenance need to be enhanced. Coated fin coils require a minimum of 5-6 rounds of plain water cleaning with a professional pump, depending on the pressure and flow. If such corrosive deposits are not removed, even a professional coating will fail. Deposits of salt, corrosive dust, etc., need to be removed from the fins with plain water or as recommended by the coater. Whether a coil is coated or un-coated, corrosive belt sites require regular deep coil cleaning to neutralize the corrosive deposits. Coating of coil fins increases the life of the coil three to four times with a proper coil maintenance program. Such a coil cleaning program also keeps power bills under control, with maximum cooling at minimum compressor work load.

General Guidelines on Coating

Surface Preparation

Coils may contain oil, dust, oxides, etc. from manufacturing, storage and transportation stages. They need to be removed, or else coating will not be fully effective.

- Pressure rinse with a high pH cleaning solution
- Rinse with fresh water
- Pressure wash with a low pH cleaning solution to reduce surface pH to 5.0 to 7.0
- Allow to dry thoroughly

Preparing Tubing Surfaces

- Clean using degreasers/soaps, etc. or as directed by coating supplier
- Follow it with primer or as per coating instructions

Recommended Equipment and Settings

Use conventional and air spray equipment for fins and tubes, or follow supplier instructions.

Evaluating Coating Application Methods

Dip Coating

In certain corrosive areas, cooling coil leaks occur below the fins, as tubes are internally and externally enhanced. In such tubes, wall thickness is highly compromised, so leaks occur within 16-24 months. Only dip coating can prevent such problems. The best method of coating a coil is by dip application. It ensures complete coverage of all fin-and-tube coil surfaces. The majority of engineers and corrosion specialists recommend and specify dip coating as the most complete method of application. This may be requested at the time of ordering the equipment, or can be done after manufacturing at a location with professional facilities. Generally, such services are not available in India, as cost, infrastructure and expertise are major deterrents. So coils are being replaced within 24 months here.

Spray Coating

Field spray applied coating is not as effective as factory dip coating. Spray coating is more successful when performed under controlled conditions such as in a coating facility. It is much more difficult to properly clean, condition and coat the coil surface in

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the field where mobility to work around the unit is hampered and where one is subject to the elements. It is strongly recommended not to use hand spray bottle/aerosol spray to coat coils greater than 2 rows or coils having more than 17 fins per inch (fpi).

Aerosol Spray Coating

Aerosol spray coating of coils is generally performed by an AC technician or home owner. It is an easy way to achieve some short term protection against corrosion in a mild to moderate corrosive environment. Recommended for windows, mini splits, PACs and small condensing units.

Considerations for Selecting a Coating Provider

- Employ a company whose primary business is coating coils, having a range of dependable coating and cleaning products conforming to international tests and standards, to suit various site requirements. Such coating has to be tested against given international standards, whether the coater is well equipped with products, equipment, trained manpower as per his principal's website. Proper coating of a coil requires techniques and procedures totally different from painting.
- Ask your contractor for the coating applicator's suggested list price and your discount price. Discount may vary with work, quantity and site conditions. Ask for a detailed analysis.
- Request a certificate of coating compliance to assure the coating is done in accordance with the specifying engineer's factory spray instructions and coating selection.
- Prior to getting the coating done, request and review a copy of the coating company's written warranty against corrosion.
- Ask your contractor if the coating is field repairable in the event it is accidentally damaged in shipment or abraded after installation.
- When receiving quotes for AC equipment and corrosion protection, request the prices be separated to eliminate unnecessary mark-up.
- Request the coating company's name and address in the event of a warranty claim.
- Request from the coating company a manual or video on coil and coating maintenance.

Conclusion

Protecting HVAC in corrosive environment is not only costly, but if not done properly it makes the unit inefficient. Worthless coating does more harm to HVAC performance and life than nature's fury. Selection of the right type of coating to professional surface preparation and proper application leads to increased life of the HVAC unit, faster payback of the additional cost, and stable efficiency throughout the increased life. In order to get the coated fin unit work efficiently, importance should be given to a minimum of 4-6 deep coil cleanings/ annum along with other regular maintenance.