



Formicary corrosion in a coil

# HVAC in Corrosive Environment

By **Mahesh R. Mehta** Ecochem Plus, Mumbai

**Part 4**

## Introduction

In the first 3 parts of this series, we have learnt about HVAC parts and the chemistry of corrosion of various metals. Prevention of coil corrosion is easier, cheaper and more effective than replacing coils or the entire system. We will now study how to protect a coil and extend its life and efficiency.

Over a period of time, several design changes have taken place to enhance coil efficiency. First, the coil face area was increased. This was followed by an increase in coil surface area, achieved through higher fins per inch. To further enhance coil efficiency, solid fins were replaced by slitted and grooved fins. Later, tubes were rifled to increase refrigerant flow. Thus, we now have coils with wafer thin fins and copper tubes with minimal wall thickness, which easily succumb to environmental and other corrosion attacks.

## Corrosion Dynamics

Two types of common environmental corrosion – pitting and formicary corrosion – can occur in as little as a few weeks after installation on metals like copper and aluminum and brazing joints. The ability to distinguish between pitting and formicary corrosion might help detect and eliminate the cause.

Pitting corrosion is typically caused by the presence of chlorides or fluorides. Chlorides are found in numerous household and industrial items. This phenomenon can be related to anything from substandard or recycled copper tubing or lubricants used in the coil manufacturing plant. In such cases, even a new coil is prone to destructive corrosion.

Formicary corrosion is on the rise nowadays, since copper tubes used are enhanced with grooving to increase heat transfer. Such coils show corrosion damage far more severe than pitting.

*continued on page 68*

## 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.

*continued from page 66*

Formicary corrosion is caused by organic acids such as acetic and formic acids. Acetic acids are used in abundance in numerous household products such as adhesives, paneling, particle boards, cleaning solvents, vinegar, foam insulation and dozens of other commonly found products in the home or commercial/industrial workplace. Formic acid is found in cosmetics, disinfectants, tobacco and wood smoke, latex paints, plywood, and dozens of other materials. The corrosion caused by these substances is usually not visible to the naked eye, although black or blue-gray deposits can sometimes be seen on the surface. Formicary corrosion can form a sub-surface network of microscopic corroded tunnels within the tubing wall, resembling ant-nest type structures that are substantially larger than the surface pinholes above them. Eventually one or more of these tunnels will progress to the surface of the copper and form a pinhole, quickly resulting in coil leakage.

Formicary corrosion can only be controlled if indoor unit coils are dip-coated, as spray coating cannot reach the tubes below the fins. Dip coating is not widely prevalent in India. Protective coatings are an option for new and old coils that are going to work in corrosive site applications and for existing coils that have been repeatedly replaced due to corrosion. Numerous coating options are available to suit the need and budget.

### Advantages of Professional Coating

Professional coatings make coils virtually corrosion-proof, when properly applied and maintained. Reducing corrosion can improve long-term consistent performance and reduce gas and spares replacement costs. Such coatings have the following technical advantages over generic/limited feature coatings:

- Conformance to various international testing standards.
- Fume protection over 1-14 pH range.
- Elongation of 200-400%, i.e. expansion and contraction of coating when the unit is working or at a standstill, keeping the coating sufficiently flexible over the tube life of over 5 years.
- Tensile strength, stone abrasion, weather ability and cut resistance.
- High UV stability.
- A range of technical coatings is available, for example non-VOC coating conforming to US FDA standards for the pharmaceutical industry.
- Special coatings are available for varying site demands, for example one that can adhere to and work on condensate water sweating pipes over a long coating life.
- Old exposed units are a demanding application, for which the coating should adhere to and penetrate through rust and protect the base metal from further corrosion.
- For tubes and pipes that have cuts and crevices difficult to reach and coat, active coatings are available that protect such areas through their vapor action.
- For fins, coatings are available that do not affect heat transfer and can withstand 1-14 pH fumes.
- Easy removal of coating, so that new coating can be carried

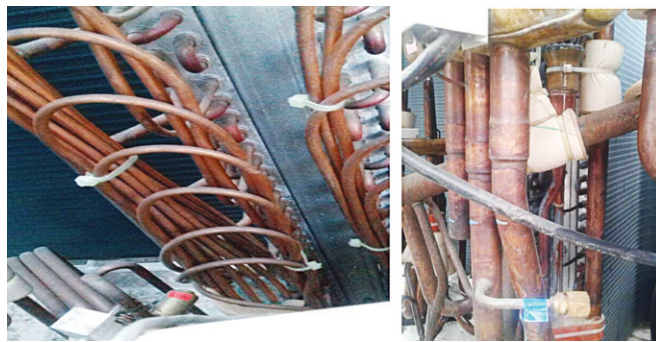


Figure 1: Uncoated VRV coils and tubes

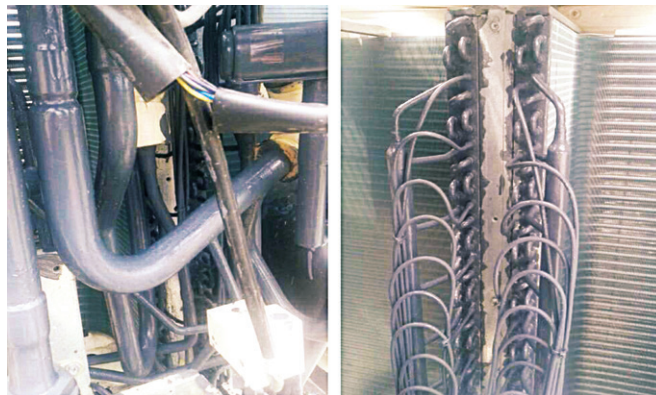


Figure 2: Professionally coated VRV coils and tubes with 200% elongation and life of 60 months

out easily. This feature comes handy when the situation demands a change or when coating life is finished.

- Single component, ready to use coatings avoid the need to mix. Incorrect mixing of components or failure to use within the stipulated time (typically 5 minutes) renders them unsuitable for use.

The disadvantage of certain generic coatings is the reduction in life and heat transfer with epoxy or PU. The reduction may be up to 30%, affecting unit efficiency and capacity loss. Generic coatings do not offer full pH range protection or elongation feature. The widely used epoxy coating has poor resistivity to UV and a few acids. New coils with generic coatings need to be oversized to offset the loss of heat transfer.

### Coating Process

#### Study the Site Carefully

Visit the site, see the surroundings and make notes of corrosive elements and types of corrosion; look for environmental causes. If possible, try to eliminate the root cause; otherwise coating is the only answer for unit protection.

#### Choose the Coating Material

A sound decision on coating material is the key to success. Part 3 of this series contained a comparative study of coating materials. It is better to overprotect. Decisions made in haste keeping only the cost in mind prove expensive in the long term. Cheap epoxy

*continued on page 70*

*continued from page 68*

or PU coatings are unreliable and may get affected by UV, causing loss of efficiency and high power cost throughout the equipment life. Under-protected units have limited life, declining efficiency, increasing power consumption, compressor failures and high maintenance cost.

Protecting old and new units needs different approaches. It might be easy to protect a new unexposed unit; but for old exposed units, suitable cleaning chemicals and skills are required so that coating adheres to the base metal firmly, otherwise corrosion will not allow the coating to get a firm grip, causing it to peel off within a short time. On pre-coated old units, removal of the old coating is necessary and more expensive than the coating itself, so it is always better to look for long term protection.

### **Protecting the Header, U-bends and Brazing Joints**

Pitting corrosion by sulphur, chloride and H<sub>2</sub>S gases is a major cause of failure when the equipment is located near a sewer, effluent treatment plant, industrial unit or dumping ground. Equipment as far as 8-10 kilometer away from such locations is under corrosive threat.

Pitting is usually visible on the exterior of the copper tube, especially on brazing joints and U-bends, with the naked eye. Pitting is caused by an aggressive attack of negatively charged chloride or fluoride ions carried to the joints. The negative ions attack the oxide film that the metal usually uses to protect itself, essentially forming a corrosion driven battery that consumes the copper. After pits have formed in copper, they will extend through the thickness of the copper tube until a pinhole is formed causing the coil to leak refrigerant.

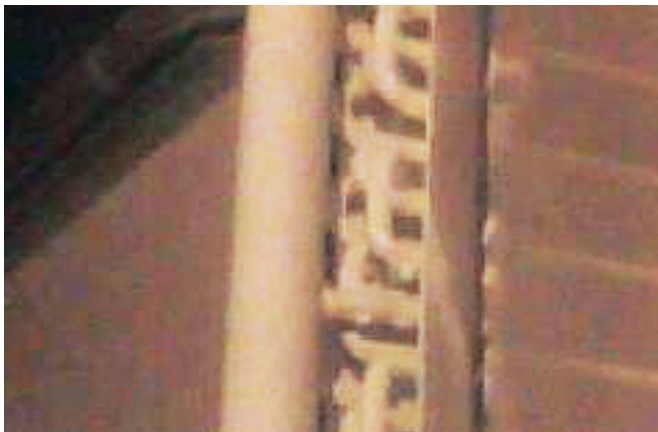


Figure 3: A coated header

Brand new units are comparatively easy to coat.

- Ensure that the equipment is coated at site after its arrival without any delay. If it is to be kept aside for some reason, ensure that it is kept fully packed and not taken out for inspection, etc.
- Ensure that the areas of headers, U-bends and tubes to be coated are dry and free from dust, oil, oxides and contamination.
- Apply the coating by spray, brush or any other method specified by the coating material supplier.

### **Case Study: Blistering Pace of Nature's Corrosive Action**

Recently, towards the end of December 2016 at a restaurant site, unprotected units were placed in a corrosive environment. During the winter, air is heavy and pollutant concentration is high at lower atmospheric heights. The new units started developing multiple leaks within a few weeks instead of the usual 4-6 months. Everyone was caught napping. Generally, a considerable time gap is seen between the first and second leak. But in this case, the leaks started increasing within a few days and weeks. Surprised by the constant leak complaints, various crack teams visited the client's site. After a lot of study, multiple reasons were found.

The condensing units were installed towards the end of December during peak winter, so cooling was compromised. The units were located in a shaft covered by louvers, reducing air circulation by 50%. Within a fortnight the building owner built a security cabin, further covering 50% of the louver area. The units were placed close to each other in the shaft, hindering their discharge and further aggravating the situation. At end of January, the units started leaking – first a trickle, and then developing multiple leaks. The indoor cooling capacity was planned 30% extra to compensate for food grilling on customers' tables. Yet, cooling became inadequate, as the condensers were not working properly. Customer footfall went down and the business suffered.

To resolve the problem, extra units were installed. Leaking coils had to be replaced with new coated coils within 3 months. The main units were shifted from the shaft to the car parking area.

- Ensure all the tubing is properly coated, including hidden tubing and tubes covered by insulation material.
- Since tubes are three-dimensional, remember to coat the backside of tubes properly. Patchy work by untrained persons can cause failure of the coating.
- Allow sufficient drying time between two coats, as instructed by the coating material supplier. Apply the requisite amount of coats carefully without any haste. Protect the freshly coated area from wind, rain, dust, etc.
- If specified, allow for maturing time before using the equipment.
- Pack the unit back in the original condition. If required, take the help of company personnel.

### **Fin Protection of New Coils**

This is the most difficult part of HVAC protection, as it requires spray painting. Coating becomes more difficult as the number of rows increases. Above 2 rows, spraying is not advisable.

- It is recommended to clean new unit coils completely to remove traces of factory oil. If oil content is high, coating adherence and effectiveness is reduced.
- Good quality alkaline solvent degreaser is best for cleaning.
- Allow the coil to dry fully, while protecting it from further dust contamination settling in. Once fully assured of dryness, move to the next step.

*continued on page 72*

*continued from page 70*

- Coating should be carried out as per the supplier's instructions. Spraying equipment should be of good quality, so that the material penetrates deep without damaging the fins. Allow curing time between two coats as per the supplier's instructions.
- Ensure that the coating is even and not clogging at the bottom, where excess material generally gets accumulated. Allow proper curing and drying time.
- Pack properly and dispatch to the site.
- Coated coil fins need to be pressure-cleaned 5-6 times every year with plain water or as per the coater's instructions. If such care is not taken, the warranty may become void. We have seen how fins are becoming wafer-thin, and the coating is just a few microns; any corrosive deposits like salt will damage the fins and coating forever.

### **Conclusion**

The moral of the story is that professional protection is required 24 x 7 to face nature's fury that can affect business. Professional protection helps to face hostile nature, boost efficiency and avoid unplanned repair costs. Any contaminant source can initiate corrosion in an HVAC unit, and the surrounding site situation can worsen the situation. ❁

***In Part 5 of this series, we will learn in detail how to protect the brazing joints and fins of old exposed equipment. Readers may send specific queries with photos and site details.***