



Formicary corrosion in a coil

HVAC in Corrosive Environment

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Part 5

Introduction

In earlier Parts of this series, we have studied various aspects of HVAC corrosion. Corrosion seems to progress in a relatively orderly manner. This orderly progression typically is: the tube colour changes; leaks develop on brazing joints and slowly expand to the entire exposed tube area; leaks multiply with passage of time, seen mostly on the header and U-bends and other areas of brazing joints. Our effort will be to catch the pre-corrosive signs and deal with them before they become cancerous. By intervening at the earliest stage, one can hope to prevent future leaks, costs associated with them and unplanned shutdowns, and to maintain unit efficiency throughout the unit life.

In Part 4 of this article, we studied the process for protection of copper tubes. Now, we will study how best we can protect coil fins, especially of outdoor units exposed to saline or industrial corrosion.

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.

Fin Coating

In new units, fin spacing has been drastically reduced to increase heat exchange efficiency with slit fins and other modified fins, as mentioned earlier. Each of such modifications acts as a retainer of corrosive deposits as contamination starts building up

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in the coil. If such corrosive deposits are not removed, they eat up the flimsy fins in no time, severely affecting heat exchange.

Modern energy efficient fins have less of flesh and bone; heavy metallic fins have given way to slim fins. These fins cannot resist the slightest of corrosive attacks. Even company-coated blue fins have their entire edges exposed to corrosive atmosphere. Such blue fin coils can give low to medium grade protection to units in residential areas. But, for industrial or sea facing units, coils cannot withstand any significantly corrosive environment. For such blue fin coils, no data of salt spray resistivity is available. This suggests that they might not be able to survive real site conditions in the long run, or even the short run.

Introduction to Fin Coating

Coils destined to work in corrosive areas, viz. saline or industrial sites, need aluminum fins to be virtually corrosion-proof when properly applied and maintained. The advantage of coatings is that they reduce corrosion, promote long-term consistent performance and reduce replacement cost by extending fin life. The disadvantage depends on the coating product, its viscosity, per coat thickness and the application process if it affects heat transfer, which could decrease heat transfer by up to 10-30%. In such a case, an oversized coil can be the answer to heat transfer loss. A few coatings are available that do not affect heat transfer even after dual coating, due to their fine coat thickness. Sometimes they might help increase coil efficiency, if we believe the coating manufacturer's claim.

Existing coils can be coated at site, if one has the right cleaning chemicals and equipment, without affecting coil efficiency and capacity. The corrosion process cannot be reversed, but it can be stopped, controlled, maximum efficiency can be restored, and unit can be life extended.

Air-cooled chillers and small window and split units are at the mercy of nature, and the industry has not been able to offer satisfactory protective solutions or simple cleaning services to extend coil life. IDU and ODU coils are three-dimensional structures, which cannot be coated as easily as copper tubes. Thus, it is always difficult to offer 100% assurance for such coated coils. Such assurance is more feasible when coils are dip-coated. I am not aware of any company offering dip-coated coils in India. A majority of fin coating done in India is through spray coating, which may not be 100% effective. Being three-dimensional structures, it is not possible to know while coating what is happening between the fins and between the fins and tubes. It is possible to over-coat or under-coat or to not coat at all. The coater's skill and experience of equipment use, coating product, etc. play a critical role here. Over-coating will affect ΔT and under- or no coating will make the coil easy prey to corrosion. Sea facing clients are ready to spend money for the right coating process. It makes economic sense.

Each of the following factors play an important role in successful coating:

- i. Ensure that coated and un-coated coils are protected properly in the factory for being dispatched to corrosive environments. Coils should survive a few weeks to a few months of life at such a site if packages are un-opened.
- ii. Existing coils or new coils should be properly cleaned to remove manufacturing-stage oil and grease traces. Such cleaning should be done thoroughly with non-corrosive but effective coil cleaners.
- iii. Professional pressure pumps should be preferred; pressure and water flow should be such as not to damage the fins, at the same time their aerosol should penetrate through the coil to remove contamination. Ensure that old coils are absolutely free of contamination, rust, scales, algae, bio-growth, etc.
- iv. Allow the coil to thoroughly dry, ensuring that it is absolutely free of water and traces of moisture.
- v. Spray the coating chemical as per the supplier's instructions and follow them fully for the type of spray equipment, nozzle size, coating process, etc. Allow it to dry and to be fully cured. The unit should be used only after the curing period is over.
- vi. Ensure that spray coating is done with maximum penetration and over-coating is avoided, or else other issues will arise. We came across one such issue where we had used imported coating that was invisible. The client was not satisfied and asked for extra coating. A few days later it was reported that ΔT had reduced considerably. We reversed the process and gave a re-coat. The site was monitored by a foreign consultant, and the job was carried out to their satisfaction. They were monitoring unit performance in a control room, and once the desired performance was achieved, they were relieved.
- vii. The dip-coating process is not covered here.

Epoxy Coating

My personal belief is that epoxy coating is not effective in Indian conditions due to the following reasons:

- Poor UV stability: India is blessed with plenty of sunlight. Add the high summer temperatures, and a majority of epoxy-coated fins coatings fail to perform.
- Rigidity. The coating needs flexibility due to base metal expansion and contraction due to working temperature variation, and rigid epoxy coating fails.
- Poor acidic resistivity. This adversely affects performance in industrial areas.
- Affecting ΔT and unit efficiency. You need to have an oversized unit, resulting in cost increase of 10-30% plus additional running cost.

Case Study

A case of old corroded units is described here to show the process that goes into making a successful transition to extend the life of a unit that earlier was not protected nor properly maintained.

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Photo 1: A dirty coil before the coating process



Photo 4: Final coating



Photo 2: Another view of the dirty coil

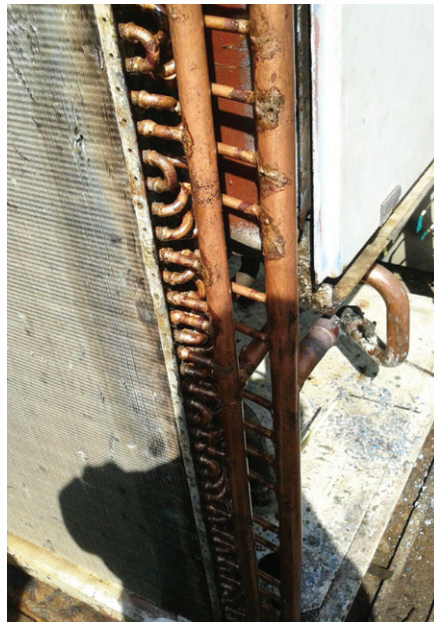


Photo 5: Coated fins and copper tube

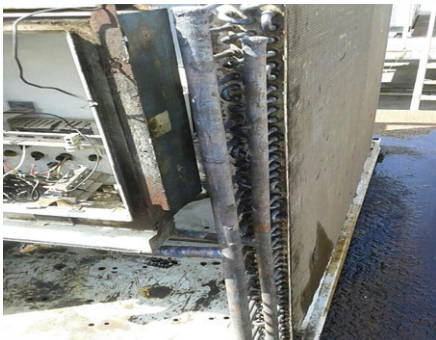


Photo 3: Contaminated coil and header



Photo 6: Restored coil area after deep cleaning and nano coating of fins (please note easy visibility of deep rows)

The unit under study was likely to be discarded as it had worked for approximately 10-12 years in corrosive environment. The fins had turned inefficient and lost heat transfer efficiency due to contamination and oxidation. We were asked to revive the fins and tubes with increased protection.

Figure 1 and 2 show the condition of the coil and fins: extremely dirty and fins oxidized to a large extent. We started with deep coil cleaning with suitable cleaning chemicals of various materials, as well as degreasers to remove oil traces. Chemicals were eco-friendly, which acted only on contamination but were safe for the metal.

Photo 3 shows the condition of the coil contaminated with oil and the header.

Deep coil cleaning process was a combination of mechanical and chemical cleaning. After a few days of hard work, the coil was free of contamination. Cleaning is the dirtiest part of the job, as readers might have noticed while getting their house painted. It takes a few days to remove old paint, plastering and surface preparation. This preparatory process lays the foundation for success, and takes 80-85% of the time. There is no short cut here.

Once the coil was fully dried up, we did the final coating as shown in Photo 4 to 6.

Conclusion

While negotiating a contract for fin coating, clients need to separate wheat from chaff. A good coating job extends unit life and gets translated into energy and money savings. The higher cost of professionally executed work can be recovered in 4-6 months, and efficiency can be maintained throughout the extended life if regular maintenance is carried out as per the coater's recommendations. ❄