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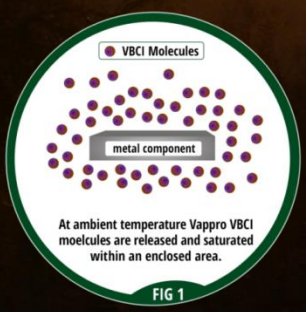

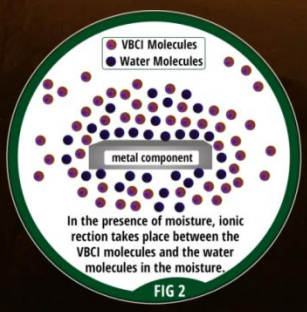

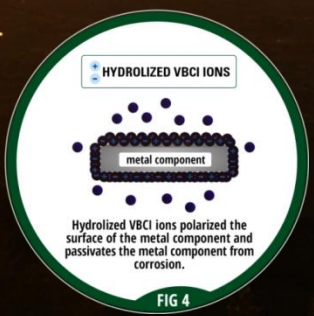

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September - October 2016

AIR CONDITIONING AND REFRIGERATION JOURNAL

The magazine of the Indian Society of Heating, Refrigerating and Air Conditioning Engineers

A&R

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SERVICE • INSTALLATION • MAINTENANCE

Volume 4 Number 3

Supplement to Air Conditioning and Refrigeration Journal

Inside

- Corrosion in HVAC Systems
- First Time Right
- All About Filter-Dryers
- Servicing Screw Chillers and Compressors
- Condensate Drain Solutions for HVAC&R

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A filter-dryer used in the liquid line

Cover design by Fezisons

Registration Numbers:
MAH/ENG/06690/13/1/97/TC
70346/98

AIR CONDITIONING AND REFRIGERATION Journal
ACR SIM SERVICE • INSTALLATION • MAINTENANCE
Supplement to Air Conditioning and Refrigeration Journal

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Printed and published by
Gautham Baliga
on behalf of Indian Society of Heating, Refrigerating and Air Conditioning Engineers.

Printed at
Fezisons Quality Printers,
Rahimtoola House, 7 Homji Street,
Fort, Mumbai 400 001.

Published at
ISHRAE Mumbai Chapter
102, 1st Floor, Sunil Enclave, Pereira Hill Road,
Off M.V. Road, Next to WEH Metro Station Gate #7,
Chakala, Andheri (East), Mumbai - 400 099.

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We have always maintained that skilling is one of the critical success factors for the growth of HVAC&R industry, as indeed of any industry. The Skill India Mission is a well-conceived programme that dovetails into the country's industrial growth targets as well as the Make in India drive. Two years down the line, how effective has the Skill India Mission been?

Let us look at one indicator of its performance. There are 913 government and private Industrial Training Institutes (ITIs) in Maharashtra. Till a few years back, an ITI was the last resort of a student who had run out of career options. But this is becoming a thing of the past. From 2.13 lakh applications for 98,000 ITI seats in 2013 to 2.53 lakh in 2014, the number of applications has been shooting up. The year 2015 saw 2.82 lakh applications for 1.27 lakh seats, only to be outdone in 2016 with over 4 lakh applications for 1.33 lakh seats. Suddenly, admissions to ITIs are in hot demand.

Why? According to a report by Teamlease, a leading recruitment consulting, human resource outsourcing and staffing company, salary levels of ITI pass-outs are on the way up. The report, titled 'Professional education versus vocational skilling: What pays better', says that salary levels of electricians were on a par with accountants in 2013 and 2015; and across most sectors that hire engineers – automotive, construction, food processing, healthcare and retail – specific blue-collar jobs were paid 10-27% higher than engineering jobs.

Curricula have been upgraded, courses have been modernized and placements are in full swing. Today, industry looks at ITIs as a source of ready-made employees, not just cheap labour. This speaks well of the change in ground situation brought about by the Skill India Mission.

In the recent past, some trades have seen admissions to full capacity: electrician, architectural draughtsman, furniture and cabinet maker, surveyor, and fitter. The AC&R trade is lagging behind in popularity. The reason is not lack of need for trained AC&R personnel. Regressive industry practices and mindsets are the blocks that inhibit the demand for formally trained persons in this trade. The industry must understand the advantages of a skilled workforce, and the need to pay adequately for skills.

In this issue, we bring you an introductory article on corrosion in HVAC systems. Another article, on the concept of 'first time right', looks at an important ingredient of customer satisfaction. The issue carries a guide to filters-dryers, and another to servicing of screw compressors and chillers. An article on condensate drain solutions rounds off our offering of features in this issue. And we have all our usual departments to keep you updated. Happy reading!

Rakesh Kumar, Technical Editor

Formicary corrosion in a coil

HVAC in Corrosive Environment

By Mahesh R. Mehta
Ecochem Plus, Mumbai

Introduction

HVAC engineers are intrigued by the corrosion of equipment and parts exposed to the environment. An attempt is being made in this article to explain the basic causes of corrosion and their remedies, so as to prevent the failure of equipment and extend its life and efficiency. The aim is to educate and arm HVAC professionals with vital information, data and case studies, so they can plan their projects better and avoid mistakes.

Let us begin this article with a question.

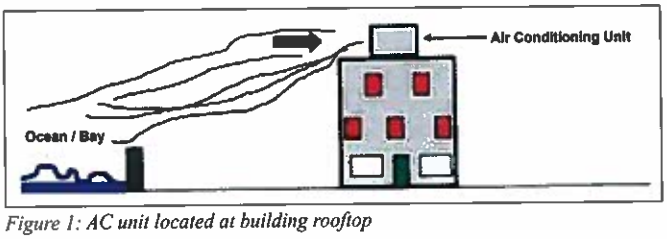

Figure 1: AC unit located at building rooftop

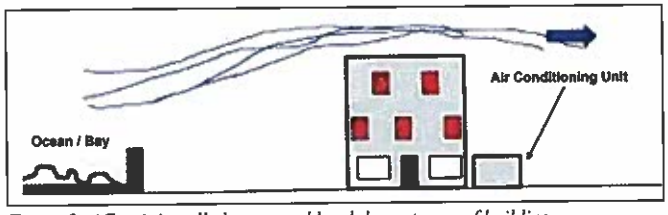

Figure 2: AC unit installed at ground level downstream of building

Refer *Figure 1* and *2*. Which is the ideal place for installing the air conditioning unit?

You will find the answer at the end of the article.

All over the world, HVAC units are continuously exposed to various types of corrosion due to saline, environmental and industrial-petro-chemical corrosive elements. The intensity of corrosion may be medium to severe. HVAC equipment, once affected by corrosion, cannot be restored to its original condition. Costs need to be incurred for repair, gas charging, testing, etc. to restore the unit. This may reduce its working life and efficiency considerably, and add to the stress on the maintenance team.

Corrosive atmosphere prevails in all major cities and towns, with untreated sewage being the major polluter. Other causes are saline corrosion due to sea breeze, industrial plants, effluent

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.

treatment plants, paper mills, etc. due to nocturnal gas emissions. Severe effects of corrosion can be found up to 10-kilometer radius of the sources of pollution, or sometimes even farther. The extent of corrosion depends on several factors including wind flow, site geography, chemistry, temperature, maintenance, etc. Corrosion damages the equipment in varying degrees, the major areas being brazing joints, headers, U-bends, fins, PCBs and control panels.

What is Corrosion?

Indian tradition identifies five vital elements (*panchabhoota*) of Mother Nature viz. Earth, Air, Fire, Water and Space. Hectic industrialization has generated excessive waste, which Mother Nature cannot process naturally. Untreated waste pollutes the vital elements. Toxic gases generated this way attack the dissimilar metals of brazing joints, making them leak through minute pinholes, and corrode the aluminum fins of coils, affecting the efficiency and working life of HVAC units to a large extent. Saline corrosion is another reason, whereby minute salt particles get trapped in the fins, slits, etc., during the monsoon. When the sun shines, the salt melts and corrodes the fins.

Ore + Energy = Metal.

This is a simplified equation to understand the corrosion process. Both the components are different in nature, so when they are stored together during the production process, they will try to separate and return back to their basic forms. Conditions like humidity and acidity hasten corrosion. The metal starts degrading on finding such favourable conditions. More the energy used to produce the metal, faster it corrodes. For example, gold is present in nature in pure form, so zero energy is used to produce it and is stored in it. Thus, it is least prone to corrosion. On the other hand, aluminum production consumes the maximum energy for converting the ore to metal, thus it is the most susceptible to corrosion.

Some common facts about corrosion are:

- Dissimilar metals in contact are prone to accelerated corrosion. This is the reason for brazing joint leaks: copper and brazing material contain different metals including silver. Noxious gases released from decaying waste, sewage, etc. easily affect these joints.
- Power released from rusting steel bars in concrete slabs cracks the structure and gets released to nature.
- Any environment can be the starting point of corrosion. It is difficult to predict Nature's ways.
- Corrosion may not manifest itself only through formation of rust oxides. Sometimes it may just alter the metal's chemical stability without affecting its strength, but with its heat transfer efficiency impaired to a large extent. At times one finds coil fins good in strength, but on minute observation one can see fin thickness affected (increased), thereby reducing their heat transfer capacity.
- Machines working 24x7 in a corrosive area succumb faster.
- Machines lying idle after installation are prone to corrosion.
- Moist air will corrode faster than dry air.
- Hot air or water will increase corrosion compared to cold air or water.
- Acids will corrode faster than alkaline media.
- Saline or salt water is more corrosive than fresh water.
- Brazing leak frequency increases during the winter and reduces during the monsoon.
- Saline corrosion increases during the monsoon.
- Polluted air will cause a higher corrosion rate compared to normal air.

Sources of Corrosion

The common types of corrosion are described below.

Saline Corrosion

This is the most common and earliest known type of corrosion in the HVAC industry. It is widely found in sea facing and nearby areas. It causes aluminum fins to corrode away in a very short time. Air conditioning units installed in coastal areas need better metal protection and regular pressure wash with plain water, to remove salt deposits. Professional coating can easily double the unit life and maintain unit efficiency during its lifetime, without affecting heat exchange. Refer *Figure 3*.

Figure 3: Saline corrosion-affected aluminum fins

Environmental Corrosion

This type of corrosion has become a very serious threat to HVAC units all over India. It has the following features:

- Brazing joints start leaking in a few months. Pinholes develop especially on headers and U-bends, starting gas leaks. Even newly installed but non-working units exposed to corrosive environment, and 24x7 working units are susceptible to such corrosion. A large numbers of units installed in such an area cause nightmares to the maintenance team, needing continuous firefighting.
- Aluminum fins change their chemical nature and become thick and yellow without losing strength, but with severely impaired heat transfer efficiency. This happens slowly after a few years of exposure.
- PCBs of VRF units, control panels and electronic/electrical contacts are attacked by corrosion due to formation of oxides, rust, whiskers, etc., causing the units to trip or fail.

How does environmental corrosion start? Mother Nature has a certain capacity to process waste and refuse slowly, but when heavily dumped, it cannot work overtime. So, the trouble haunts in the form of various corrosive substances generated during the decaying process, viz. sulphur, chlorine, solvents, etc. A small, untreated sewer passing near the site is sufficient to deliver a knockout blow to small or large air conditioning equipment. Sites located near dumping grounds are widely known examples of environmental issues. Some examples are Noida in NCR (sewer), and Malad and BKC in Mumbai (sewer and dumping ground).

Figure 4: Untreated sewers are major polluters

Industrial Corrosion

This type of corrosion is widely prevalent in large industries like petrochemical, chemical, fertilizer, paper mills, effluent treatment plants and tanneries, where a cocktail of gases creates havoc inside the factories and its surroundings. A notorious example is the Taj Mahal's marble getting a yellow tint from petrochemical complexes several miles away. A multitude of corrosive pollutants can be found in such environments, and selecting the right solution for a long life protective coating is not an easy task in such aggressive environments. An IT site near Kolkata, nestled amidst farm land and greenery, had a severe setback as an untreated waste sewer channel barely one meter wide from a small tannery was passing a few meters away. Before the occupants entered, corrosion had made inroads, heavily affecting the entire HVAC system, steel interiors, steel reinforcement inside concrete slabs, etc. Steel stored at the site corroded at lightning speed, and when it went inside the slab, it was ready to do more harm than good. One could see concrete slabs with cracks in the unoccupied building. The air-cooled chillers, which were installed but lying un-used, had multiple leaks. See *Figure 5* depicting the corrosion-affected header.

Figure 5: Corroded header due to gases from untreated sewer

Table 1 lists the common chemical contaminants.

Effects of Corrosion

Corrosion manifests itself in two ways:

Pitting

Pitting is caused by exposure to fluorides and chlorides. Fluorides are present in municipal water supplies, while chlorides are found in a variety of products including detergents and carpet and fabrics cleaners. Pitting occurs when chloride or fluoride ions are transported to the metal via the condensate. The ions attack the metal, forming pits that make pinholes, causing the coils to leak the refrigerant.

Formicary Corrosion

Metals exposed to acetic or formic acids undergo such corrosion. These acids are found in household products including cleaning solvents, insulation, adhesives, paints, plywood and many other materials. This type of corrosion is not always immediately visible and sometimes presents itself as black or blue-gray deposits. Formicary corrosion creates tunnels within the tubing that result in pinholes forming in the coils, again often leading to refrigerant leak.

Table 1: Common Chemical Contaminants

Contaminant	Type of Industry	Source of Contaminant	Potential Colour of Corrosion on Un-protected Copper
Sulfur Oxides	Pulp, paper, incineration facility, fossil fuel burning power plant, LDO/FO burning power plant	Process Emissions & Products of Combustion	Black Blue
Nitrogen Oxides	Pulp, paper, incineration facility, fossil fuel burning power plant, LDO/FO burning power plant	Process Emissions & Products of Combustion	Black Blue
Chlorine and Chlorides	Cleaning agent processing, water treatment facility, salt mining and processing, swimming pool, sanitizing agents, paper mill	Process Emissions Water Disinfection Process By-Products Gaseous Emissions	Brownish/yellow and greenish
Ammonia and Ammonia Salts	Chemical industry, fertilizer plant, waste water treatment plant, agricultural application	Process emissions and by-products, waste digestion, animal waste, fertilizers	Black
Hydrogen Oxides	Waste water treatment facility, paper mill, petroleum refinery	Sludge processing	Black

Note: Identification of contamination based on colour may be misleading. Indication given here is indicative; the final result would be different if there is a combination of gases working at the same place.

Tackling Corrosion

- The site needs to be inspected closely. Once the effects of corrosion are noticed, try to locate the source, which can be a few meters to several km away. Remember the Taj Mahal, which is being affected by the Mathura Refinery.
- Coil failure may start within a few weeks in severe corrosive environment, to a few years in mild to medium environment. Implementation of an immediate protection plan can help reduce the severity of failure. Once the corrosive process sets in, it can result in major recurring costs that keep increasing.
- Be careful when in the proximity of conditions like salt air, acid rain, animal, bird and insect fluids or droppings, automobile emissions, laundry, swimming pool, jewelry unit, fertilizer plant, refinery unit, and pollutants such as sulfur oxides and nitrogen oxides.

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source of water immediately by performing a thorough leak check. Whenever the indicator shows a presence of moisture, replace the filter-drier.

Relief valves

Relief valves protect the system against potentially dangerous effects of over-pressure. To ensure against damage to the equipment and possible injury to personnel, these devices must be kept in peak operating condition.

At least once a year, disconnect the vent piping at the valve outlet and carefully inspect the valve body and mechanism for any evidence of internal corrosion or rust, dirt, scale, leakage, etc. If corrosion or foreign material is found, do not attempt to repair or recondition; always replace the valve. If the chillers are installed in a corrosive atmosphere, or the relief valves are vented into a corrosive atmosphere make valve inspections at more frequent intervals.

Float valve

Inspect the float valve once every five years, or when the machine is open for service. Remove the float valve access cover, clean the chamber and valve assembly, and check that the valve moves freely. Ensure that the openings are free from obstructions, examine the cover gasket, and replace if necessary.

Leak testing

The entire chiller should be leak tested annually. Because HCFC-22 and HFC-134a are above atmospheric pressure at room temperature, leak testing can be performed with refrigerant in the machine. Be sure the room is well ventilated and free from refrigerant to keep false readings to a minimum.

Before making any necessary repairs to a leak, transfer all refrigerant from the leaking vessel. If the chiller has been opened up for service, the machine or the affected vessels should be pressurized and leak tested.

Storage tank

For routine maintenance, refrigerant isolation valves allow refrigerant storage in the chiller. If absent, storage tanks and transfer procedures must be used. If a storage tank is used to hold refrigerant during service, leak test the tank on an annual basis.

If the storage tank contains a pumpout compressor, the oil should be checked annually and changed as needed. Also, run the compressor to check for proper operation. Check pressure switches and calibrate if necessary.

Controls

Control maintenance is generally limited to cleaning and tightening of connections. Vacuum all cabinets to eliminate dust buildup and debris from components. With microprocessor controls, verify that the most recent control software version is installed.

Check the service history for abnormal values or alarms and make adjustments as necessary. If condenser water control is used, verify that the pneumatic or electronic controls are operating correctly to ensure bypass when needed. Annually check all pressure transducers against a good pressure gauge.

Motor starters

For air-cooled mechanical starters, follow manufacturer instructions for contact replacement, lubrication, and other maintenance requirements. Periodically vacuum or blow off accumulated debris on the internal parts with a high-velocity, low-pressure blower. For water-cooled starters, in addition to normal maintenance, starter jackets must be inspected and cleaned as required.

Other services

Always speak with the facility personnel that have daily exposure to the equipment. They can provide valuable information regarding chiller operation and servicing needs.

Keep a log of all basic data, such as compressor amps and volts, suction and discharge temperatures and pressures, oil pressure, etc. This provides a baseline of comparison for future data.

Conclusion

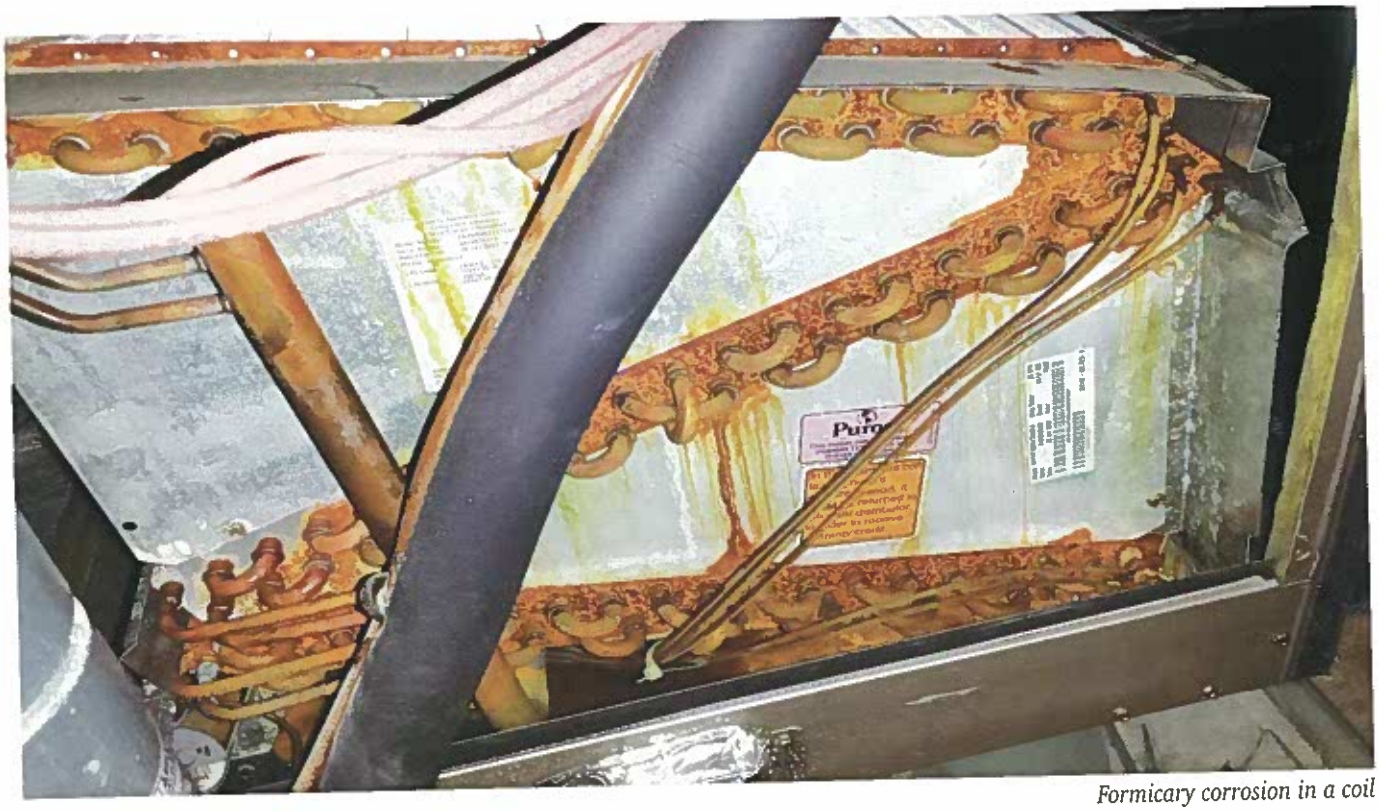
A well-planned service program will return dividends to the building owner and manager in the form of comfort, reduced operating costs, and peace of mind.

HVAC in Corrosive Environment *continued from page 88*

- HVAC manufacturers have made major investments to achieve better cooling and space reduction through more fins per inch, improved fin designs, rifled tubing, micro-channel coils, etc. If such units are allowed to be exposed to nature's fury, these investments would be lost in a few years.
- There is no single solution for all corrosion situations. At one site, directly facing a creek, building façade and louvers are blown away every monsoon. Damage to HVAC installation on the terrace is continuous. At another normal safe site, the OEM unit was coated. The coil side exposed to West had the coating fading away due to harsh sunrays from noon onwards, exposing the coil fins.
- Fin coating will extend unit life; in addition, regular coil cleaning with high-pressure water should be planned, especially during and after the monsoon. Its frequency should be decided based on the salt deposits observed. In severe cases, cleaning frequency of 15-30 days is necessary.

Conclusion

Coming back to the question posed at the beginning of this article, *Figure 2* is the correct answer from the viewpoint of corrosion. This location is ideal for saline corrosion protection. The location in *Figure 1* would provide better condenser cooling, but during the monsoon and on windy days, the coil would be exposed to high wind speeds up to 100 km/hour, which may damage the coil fins.



Formicary corrosion in a coil

HVAC in Corrosive Environment

Part 2

By Mahesh R. Mehta Ecochem Plus, Mumbai

Introduction

In Part 1 of this article, published in the September-October 2016 issue of AC&R SIM, we learnt about corrosion and its general effect on HVAC equipment. In Part 2 of the article, we shall study how corrosion affects modern HVAC units.

External coil corrosion appears to be on the rise. While coil corrosion can stem from poorly manufactured copper, chemical residue from coil manufacturing and other such causes that initiate the corrosion process long before the coils arrive on a job site, the majority of problems occur when environmental acids corrode coils from the outside in. HVAC units exposed to corrosive environments lose their body, fins, brazing joints of copper tubes like headers, U-bends and internal pipeline, testing instruments and control panels/PCBs completely or partially. Condenser units get affected by moisture much faster than cooling units. Units located near an open sewer, effluent treatment plant, saline exposure and chemical-industrial zones are affected faster than units located in residential areas.

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.

Improvements in Coil Design

Almost all manufacturers of HVAC&R equipment have made significant strides in an effort to achieve higher star ratings on their equipment. Equipment operating today saves the user operating costs. Finned tube heat exchangers are not manufactured the same way as they were 10 years ago. Simply stated, equipment today is much more efficient in operation than equipment manufactured 10 years ago. In the development of higher efficiency equipment, typical changes include increasing the fins per inch (fpi), increasing the square foot face area and adding configured or enhanced fin areas to increase air flow through the coil for better heat transfer. Most manufacturers have opted for coil design changes rather than mechanical changes to improve equipment efficiency. Coil changes were the quickest and easiest to make: changing the fin die was all that was required. Some OEMs

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are now offering pre-coated fin stock in the construction of coils as corrosion protection. This option is effective inland for condenser coils, but not for coastal or industrial applications. These coils also do not go through testing, unlike post-coatings. Another drawback is un-coated fins at cut edges.

Enhanced Fins

A common method of providing higher heat transfer is by punching patterned slits in fin surfaces. In addition to weakening the structural integrity of the fins, these slits entrap contaminated particulates that accelerate the corrosive process. Enhanced fins are not easily cleaned and often the leading fin edges are compromised during corrosion attack. Since there are increases in the fins per inch count, it means fin stock is much thinner and, with added enhancements, much quicker to deteriorate.

Recycled Aluminum

Much of today's aluminum is recycled. Aluminum products, including fin material, may also be manufactured with recycled aluminum. Recycled aluminum is not as corrosion resistant, since it is not as pure as virgin aluminum from bauxite. Recycled aluminum contains impurities from the re-manufacturing process. In addition to white rust (aluminum oxidation), it is not uncommon to see specks of red rust on aluminum fins when subjected to a corrosive environment.

Rifled Tubing

Figure 1: Rifled tube

Tube rifling is a method used to increase refrigerant velocity through coils. The quicker refrigerants move, the faster the cooling/heating cycle. Quicker cooling means less energy consumption and a better star rating. Unfortunately, the walls of rifled tubing are very thin. In acidic and alkaline environments, when cooper is attacked, these thin walls allow failure at quicker rates. This occurrence is most common in environments containing sulfuric acid, sulfur, and/or hydrogen sulfide. A common occurrence is leaking refrigerant. Such incidence is also known as the ant's nest due to its structure. *Figure 2* shows a typical ant's nest corrosion.

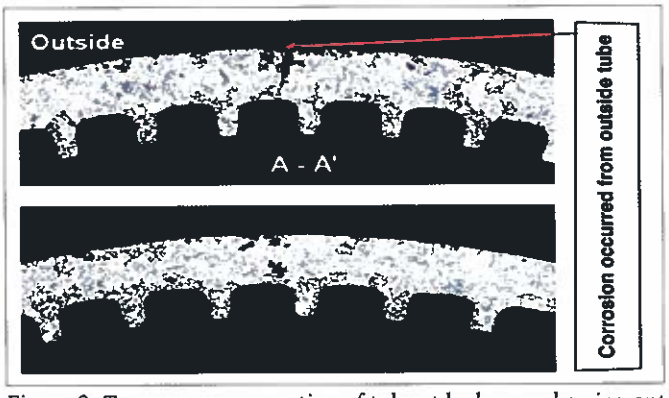

Figure 2: Transverse cross section of tube at leak area showing ant nest kind of corrosion

Figure 3 shows corrosion in a cooling coil occurring below the fins, which is very difficult to repair. Dip coating prior to installation is the only answer, if coating of tubes has not been done at the time of production.

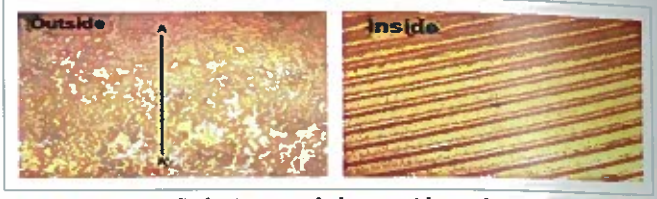

Figure 3: Magnified picture of the outside and inside of a tube surface at corrosion area

Figure 4: Micro-channel coils

Micro-channel Coils

These coils are constructed from seprately extruded components, which are then factory-assembled and brazed to construct a coil. Delicate tubes run horizontally into a manifold tube. Once the tube is damaged, it is hard to repair. Repairing and brazing aluminium is more difficult than copper. New technology makes it difficult to find comptetent repairers.

Figure 5 shows how dirt contamination gets trapped in a clean section, which is difficult to remove. Inside-out cleaning operation in large units is even more difficult, leading to reduction in heat exchange. When moisture mixes with corrosive deosits, corrosion follows rapidly, ending in coil destruction. Special accessories are needed to clean such large units.

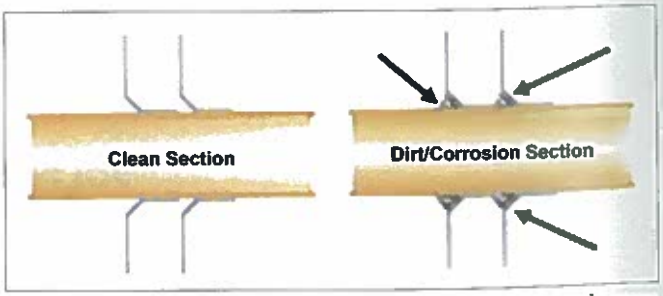

Figure 5: Dirt getting trapped in a micro-channel heat exchanger

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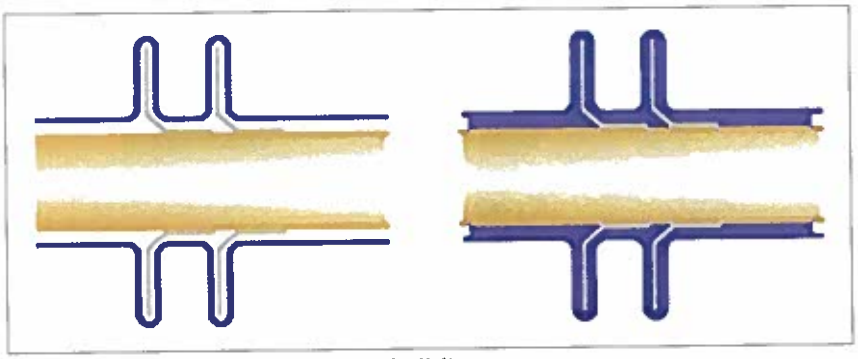

Figure 6: Coating heat exchanger to seal off dirt traps

Figure 6 shows how coated units protect the heat exchanger from contamination, as dirt traps are sealed off. It would be wise to confirm from the coater that such coating does not affect ΔT, which should not reduce by more than 1% as a general thumb rule, especially for fin area.

Types of Corrosion

There are many types of corrosion. The most common types of corrosion associated with coating protection of structures and equipment are galvanic and general corrosion. These types of corrosion can lead to equipment failure.

Galvanic corrosion results from the current caused by a galvanic cell, which is a cell consisting of two dissimilar metals in contact with each other and with a common electrolyte. An electrolyte is an ion conductor, usually an aqueous solution.

General attack corrosion is corrosion that happens in a uniform manner.

Economic reasons as well as formability and heat transfer ability make copper tube aluminum fin coils the most popular material for HVAC&R applications. Corrosive environment, such as salt air, prevalent in certain industries affects copper and aluminum in HVAC units. When aluminum and copper alloys in a coil are placed in a corrosive environment, they are highly susceptible to galvanic and general attack corrosion. They corrode and deteriorate quickly if not protected by a corrosion resistant coating.

While corrosion can take one or more forms, the mechanism of attack in aqueous solutions involves some aspects of electrochemistry. There will be a flow of electricity from some areas of the metal surface to other areas through a solution capable of conducting electricity, such as water, hard water or even condensed moisture containing soluble gases or salts. The term anode is used to describe the portion of the metal surface that is corroded and from which current leaves the metal to enter the solution. The term cathode is used to describe the metal surface from which current leaves the solution and returns to the metal.

Galvanic corrosion is more commonly seen in cooper tube aluminum finned coils. It causes fin corrosion and ultimately coil destruction. The efficiency of the unit declines fast. Units located in environmental/ industrial corrosive areas retain good fin strength, but their heat exchange property is considerably depleted (see *Figure 7* and *8*). Such slow coil destruction is difficult to notice over a period of time.

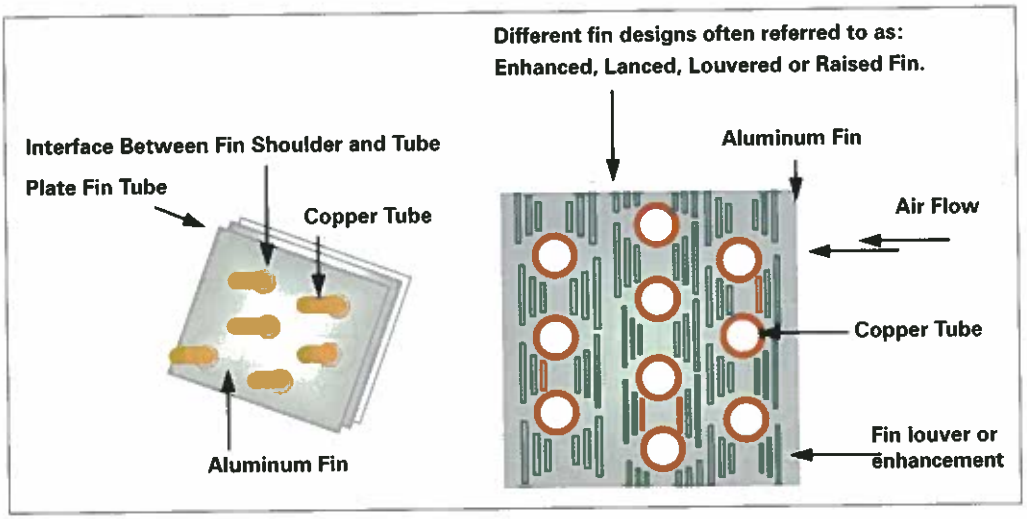

Figure 7: Basic coil construction – non-louvered and louvered fins

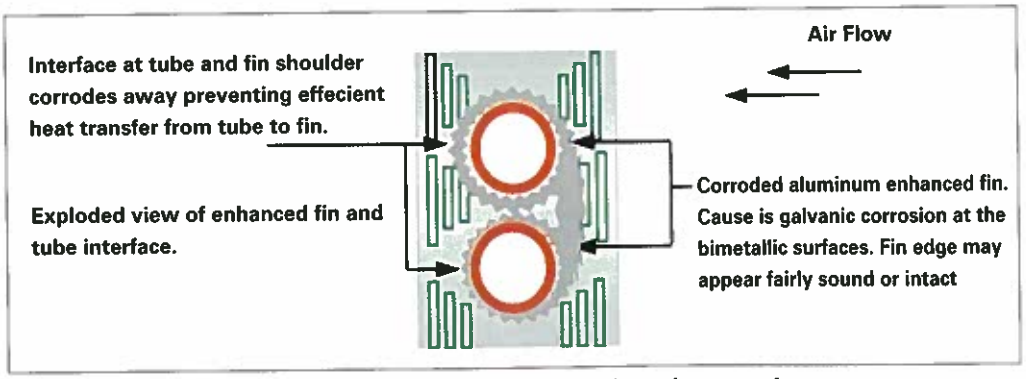

Figure 8: Galvanic corrosion begins at interface of aluminium fin and copper tube

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Galvanic corrosion starts at the interface of the tube and fin. An uncoated fin deteriorates faster; the lost metal creates gaps between the tube and fin shoulder, degrading coil efficiency and reducing its performance. Visual destruction of the coil from corrosion is evident. It is not possible to repair it by coating, since there is no way to bridge the gap at the fin-tube interface; corrosion deteriorates the joint or the fins are embrittled.

The effect of corrosion can be felt in a few weeks to as long as a few years, during which period the unit's working and efficiency degrade slowly, or within a few weeks it may start leaking from the brazing joints . The result varies from low fin corrosion to rapid degradation of brazing joints causing leaks. It ultimately leads to premature unit failure.

Coil Corrosion Examples

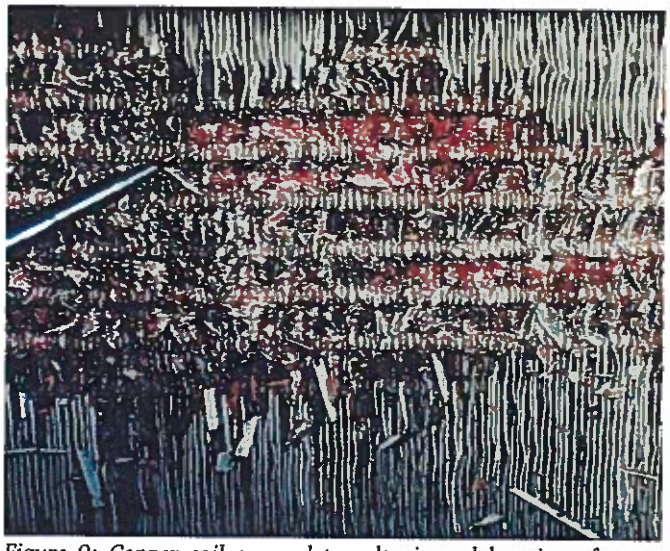

Figure 9: Copper coil exposed to salt air and burning of sugar fields, located 2 km from sea shore, for 18 months showing loss of fins and built-up oxides

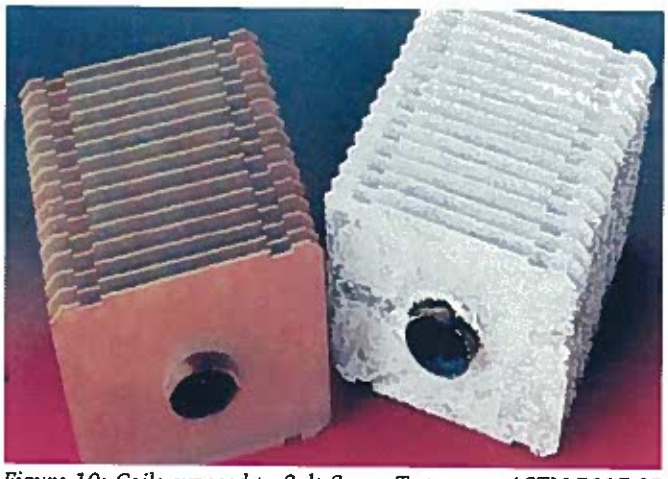

Figure 10: Coils exposed to Salt Spray Test as per ASTM B117.85 for 360 hours; corrosion on the untreated coil would shorten equipment

Figure 11: Old header with paint and rust oxides

Figure 12: Chemically cleaned and coated header

Figure 13: Old coil with dirt and corrosion

Figure 14: Restored coil after fin cleaning and nano coating

Case Study

In a recent assignment, the author has revived an old unit on the verge of being junked, by repairing the header and U-bend, deep coil cleaning and fin coating. (Note increase in fin sharpness in the final photo). Old copper tubes with multiple coating were also chemically cleaned and re-coated.

Conclusion

Today's coils are more susceptible to corrosion and abrasion attack, which often leads to accelerated coil failure, increased operating costs, increased head pressures and unit failure. It is more important than ever that contractors, engineers, consultants, and owners should consider protecting their equipment with a high quality professional protective coating process. It is also important to establish a proactive preventative maintenance program, which should include cleaning coils with a product that is not harsh and abrasive. A clean coil is an efficient coil. Efficient equipment helps building owners save on the bottom line. The responsibility for maintaining a healthy coil lies with the owner.

Volume 20 Number 1 January - March 2017

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- Avoiding Chilled Water Distribution Problems
- HVAC in Corrosive Environment - Part 2
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March 2018

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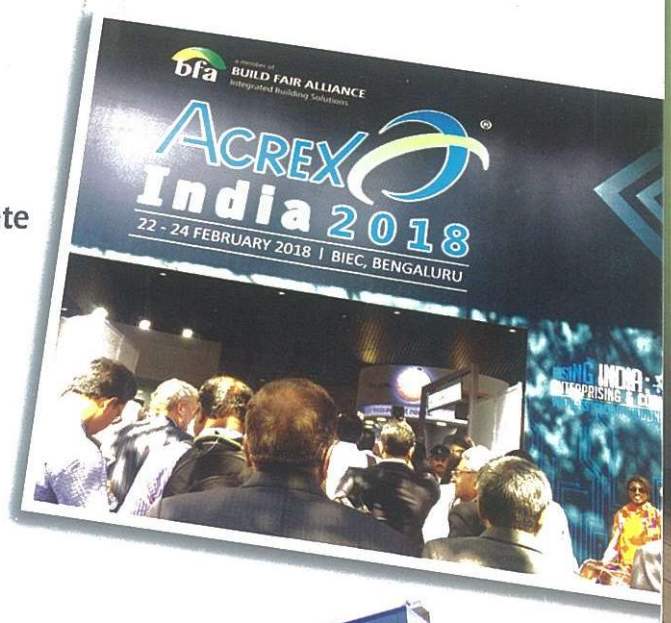

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ACREX is globally one of the largest exhibitions in this field

Cover design by Fezisons shows Reliance Corporate IT Park Building 22, which has been admitted to the ACREX Hall of Fame

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Formicary corrosion in a coil

HVAC in Corrosive Environment

Part 6

By Mahesh R. Mehta Ecochem Plus, Mumbai

Disruption in HVAC Industry

Everyone is talking of disruptive forces, which change market forces instantly. The entry of Jio in the mobile market and Tesla in the automobile market are such examples when a new breed of competition changes the market beyond recognition. Is the HVAC industry fighting such disruptive forces? Yes. Who is behind such disruption? Nature's forces. The industry is competing against Nature, and should not take it lightly.

The HVAC industry is moving towards energy efficient units. Clients want power savings. The industry has introduced various technologies, e.g. higher fins/inch (FPI) and rifled tubes, to get maximum flow and efficiency within limited space. Can such units cope with corrosive forces? Signals coming from the field are very discouraging. Innovative clients staying in corrosive areas, who have adopted new 5 star technologies and inverter units, are finding it hard to believe that their IDU coils, even from leading brands, are barely able to survive12-15 months. Leaks are seen coming from below coil fins even from straight tubes, where no joints exist; this never occurred earlier. ODU fins are also getting corroded in no time. New types of

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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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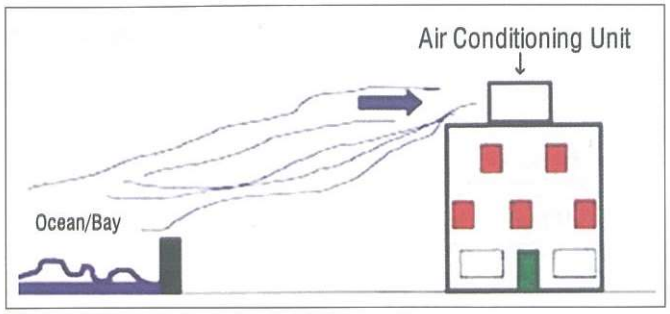

Figure 1: AC unit located at building rooftop

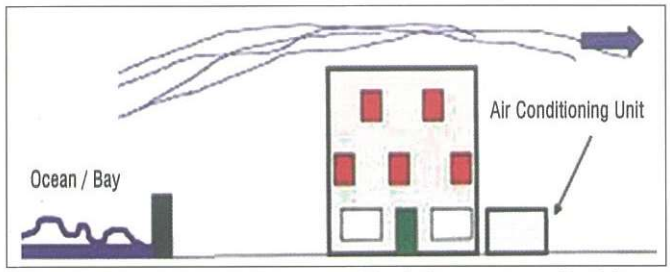

Figure 2: AC unit installed at ground level downstream of building

corrosion complaints are on the rise; even PCB failures are on rise. What is the reason?

Let me recall *Figure 1* and *2* from Part 1 of this series published in the September-October 2016 issue of *Service, Installation, Maintenance* (SIM) supplement to the *Journal*. Which is the ideal place for installing this air conditioning unit?

Nature's Dictates

The first point to be noted in *Figure1* is that in the HVAC vs. corrosion fight, basic HVAC principles are being thrown to the winds by Nature's dictates. Worldwide the practice is to install HVAC units in the open, but saline corrosion will make it a wrong choice.

Higher FPI

The second point is, energy efficient units have more FPI for compact cooling; in such a situation, fins are becoming thinner and thinner, so they easily succumb to saline and corrosive forces.

Rifled Tubes

The third point is, copper tubes are rifled, with their wall thickness drastically reduced, and the new refrigerant gases work at higher pressure. Internal gas pressure ranging from 250-550 psi acts as an invisible hand for faster damage. This leads to tube ruptures, resulting in leaks in no time. Please see *Figure 4*.

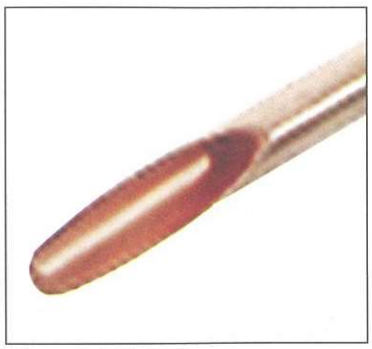

Figure 3: Rifled tube

Unprotected PCB Brains

The fourth point is, inverter units with unprotected PCBs brains are easily corroded within a short period.

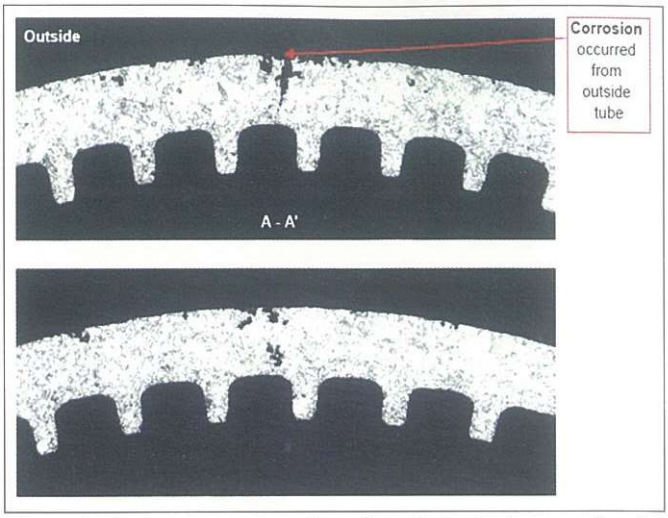

Figure 4: Transverse cross section of a tube at leak area, showing corrosion (A-A')

Epoxy Precoating

The fifth major concern is that some OEMs bring their air cooled chillers pre-coated from abroad; they are generally coated with epoxy, which has seen the highest failure ratio in Indian conditions. Due to the large difference in environmental conditions and crude maintenance practices (for example, maintenance personnel jumping on air cooled chiller parts for coil cleaning), a successful protection in one country cannot be replicated elsewhere. A leading retail chain project head recently confided to me that micro channels coils are a strict no-no in their premises. Technological advancement has not brought any change in cleaning and maintenance practices. OEMs who invested heavily in such technology are having second thoughts.

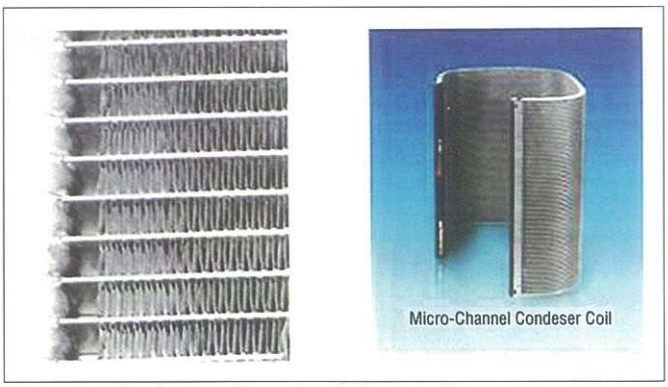

Figure 5: Life of micro channel coil shortened by crude maintenance practices

Crude Maintenance Practices

The sixth serious concern is after sales service, which each customer needs for maintaining the units in their original efficiency plus for stretching equipment life. Such issues are not adequately addressed. Over-enthusiastic but ill equipped

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contractors clean such units with very high water flow, like garden hoses with flow of 30-50 liters/minute, and damage the fins instantly and permanently, without any scope for repairs. Such damages may be passed off as corrosion damage, and the client is forced to buy new equipment/coils in 2-5 years.

In brief, the 5 star energy saver units have been short changed on the metal thickness of tubes and fins, which are easily prone to Nature's non-stop corrosive attack. If it survives Nature's attack, crude maintenance can complete the remaining job. OEMs need to act fast, or else 5 star energy saver units will meet a premature death.

Roles of Different Players

OEMs

Every area of HVAC technology – compressors, fins, tubes, PCBs, inverters – is advancing at a faster pace than before. So is corrosion. There are some maintenance and reliability truths that should be applied at the earliest. Serious complaints that bring the most pain need to be identified.

Dealers and Sales Teams

They need to educate customers well in advance. Dealers have pushed the 100% micro channel aluminum coil out of the market, as they were ill equipped to either service them or braze them. If possible, they should promote products/coatings that have stood the ground. Investing in technology for equipment servicing, regular studying of units in corrosive areas, involving the clients too in the process as action can be taken at the earliest if traces of corrosion are seen.

Buyers

They need to understand the technology and make judicious choices while going in for energy saving products.

Conclusion

Let us sum up the present situation.

a. OEMS are in a race to build Unicorn products, but environmental changes need to be respected.
b. HVAC industry is already knee-deep in the environmental corrosion game, and is not immune to what is happening at the end customer's place. More than winning market share, it is high time to build heavy duty plus energy saving products. OEMs must strengthen their products both internally and externally.
c. The HVAC industry needs to take into its fold the anti-corrosive industry at the earliest.
d. The time has come for OEMs, academics, designers, engineers and other stakeholders to do some disruptive thinking.
e. Corrosion in HVAC, like cancer, seems to progress in a relatively orderly manner. How can the HVAC community unite against it? The way we address the crisis will define our community for decades.

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(b) Fins Coating☐ ..... has been carried out by us for
M/s M.S.System, 122,Pioneer Ind.Est., Jogeshwari(E)M-60. ..... at there client site
M/s .Technimont ICE,Mind Space,Link Rd.Malad(W),Mumbai. .....
situated at place : Mind Space, Malad(W). .....

The coating work is carried out by using (a) M/s Magna Chemicals, Singapore product, Rust Guard. This product is approved by US Military & NATO, MAGNA RUST GUARD, Meets MIL-C-0083933 (MR), MIL - C- 16173 D (Grade 4).

The user will take care to protect the film from any external damage, & in case of damage or leak of gas, will inform us immediately, & if found due to our workmanship error, we will recoat the damaged area free of cost during warranty period. NO other Guarantee / warranty or compensation of any kind will be paid by us.

Nos. of unit coated by us : VRV cond. units 18 HP x 2, fins & tubes coating... 5 years
Cooling coils fins coating...24 months
Total TR coated : Cooling coils Headder & U Bend tube coating..5 years x 9 unit
Coating period : Pipe coating of approx.192 mtrs... 24 months. (B.green)
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Warranty valid only for free coating of damaged area.
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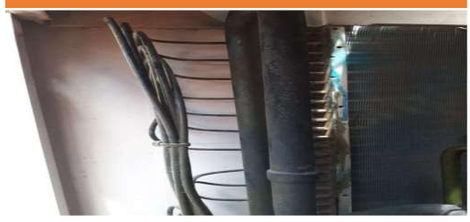

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