September - October 2014

AIR CONDITIONING AND REFRIGERATION JOURNAL

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

A&R

SIM

SERVICE • INSTALLATION • MAINTENANCE

Volume 2 Number 3

Supplement to Air Conditioning and Refrigeration Journal

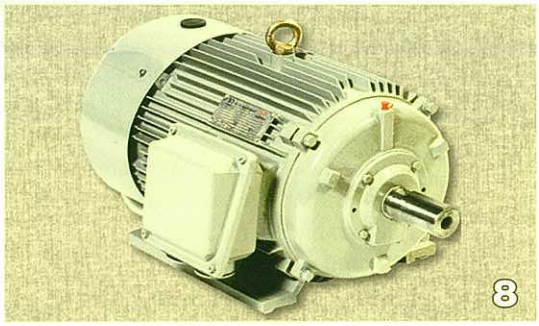
Inside

www.ishrae.in

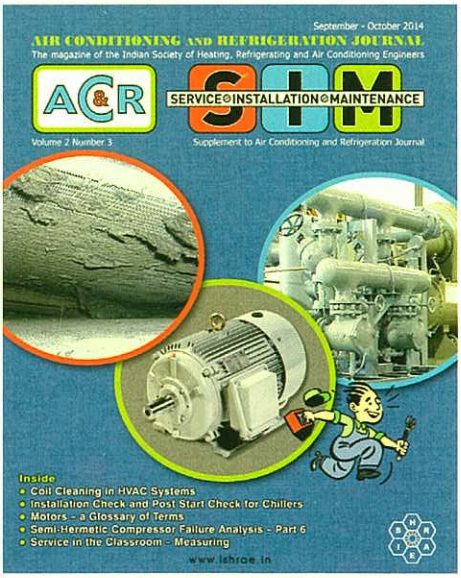
CONTENTS

Index to Advertisers

A condenser coil in need of cleaning



A three phase totally enclosed fan cooled squirrel cage motor



Cover design by Fezisons

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

A condenser coil in need of cleaning

Coil Cleaning in HVAC Systems

By Mahesh Mehta
Proprietor
Ecochem, Mumbai

Introduction

We know that a HVAC system spreads air, but many of us are not fully aware of the various air-borne contaminants, virus, bacteria, etc. that this air spreads. These organisms get trapped in condensers and cooling coils, creating air blockage that results in reduced air flow. This, in turn, affects heat transfer, thereby increasing power consumption. Viruses such as measles, influenza, tuberculosis and legionella, transmitted via air, can flow through the HVAC system and create serious health issues.

Coils are three dimensional structures and hence are not as easy to clean as a tabletop or a floor. Once air contamination deposits start building up on the fins, the task becomes more strenuous. Common sources of contamination are oil, grease, hair, powder, fibers, chemical fume deposits, etc. There are three issues that arise from this situation:

1. By insulating heat transfer surfaces, these deposits increase the burden on AC compressors.
2. They reduce heat transfer.
3. They provide food and water for bio-growth in cooling coils.

If a coil is not cleaned properly, damage by choking or breeding colonies of mold, bacteria, fungus, etc. is certain. This affects users' health. Just imagine the havoc it can cause in heavily populated areas like IT offices, call centers, BPOs, hotels, entertainment venues and wedding halls.

Modern coil designs are getting more complicated to increase cooling power. There are more fins per inch, slit fins and thin fins, corrugated fins and tubes etc. All this makes coil cleaning a difficult task.

About the Author

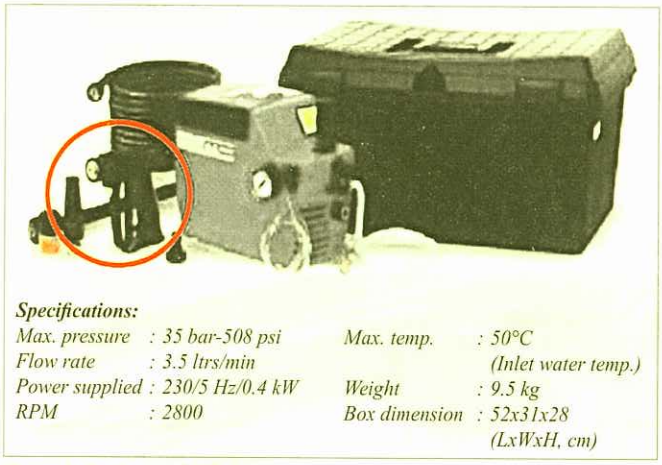
Mahesh Mehta entered HVAC industry accidentally, being a Textile Engineer. He started by marketing eco-friendly non-toxic imported chemicals in Western India in 1999, conforming to standards like RoHS and MIL. He then started executing turnkey orders for coil cleaning in industrial AC plants with imported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

Coil cleaning should be safe and an ideal combination of mechanical and chemical cleaning. Effective chemicals will loosen the contaminants while a professional pump will flush them out without any mechanical or chemical damage to the coil. Dry contaminants can be vacuumed. Use of plain water cleaning with professional pressure pumps may be adequate for major dry contamination cleaning operations but when the contaminants are oil, chemicals, food particle and bio-growth, the choice of an effective and correct chemical is very important.

Selecting the Right Pump

Professional pumps are sturdy, work longer and have various additional features that make coil cleaning easy. They also have chemical tank/ injection control on small palm sized guns, ceramic pistons, pressure gauges, auto stop, etc. User friendly pumps enable the worker to easily clean 4-6-8-10 row AHUs; he has to just aim-n-shoot without thinking of chemical mixing-stopping-running-plain water cleaning-stopping-repeat, etc. Arming the worker with professional equipment improves his productivity. The pump should have:

- Right pressure (up to 35 bar for window/split/indoor units, 80-130 bar for 4+ row coils).



Specifications:

Max. pressure	*: 35 bar-508 psi*	*Max. temp.*	*: 50°C (Inlet water temp.)*
Flow rate	*: 3.5 ltrs/min*		
Power supplied	*: 230/5 Hz/0.4 kW*	*Weight*	*: 9.5 kg*
RPM	*: 2800*	*Box dimension*	*: 52x31x28 (LxWxH, cm)*

Figure 1: Professional AC cleaner

Specifications:

Max. pressure	*: 130 bar-1900 psi*	*Weight*	
Flow rate	*: 8.33 ltrs/min*	*VIP*	*: 18*
Power supplied	*: 230/5 Hz/2.2 kW*	*Pro Laser*	*: 26*
RPM	*: 2800*	*Box dimension*	
Max. temp.	*: 60°C (Max. inlet water temp.)*	*VIP*	*: 35x22x23*
		Pro Laser	*: 34x35x max 107, min 89 (LxWxH, cm)*

Figure 2: Triplex pump

- Right water flow (approximately 3 l/m for window ACs, 8-10 l/m for 4+ rows coils).

Figure 1 shows a professional AC cleaner with a small gun and nozzle, pressure gauge, chemical inlet, water inlet with filter. The outer box is also used as water container.

Heavy duty professional pumps have higher flow and can flush out contamination faster from deep areas. *Figure 2* shows a triplex pump with ceramic pistons, pressure adjustment, built-in detergent suction, pressure gauge, electric motor with thermal protector, high/low pressure head with pencil and jet fan settings, high pressure hose, gun and lance.

Table 1 shows what kind of pump may be used where.

Table 1: Types of cleaner pressure pumps

S. No.	Type	Where to be used	Precautions
1	Hobby pump	Home use, hard surface cleaning	Not suitable for HVAC cleaning
2	Professional low bar pressure	Useful for window, split, cassette etc. with small gun	Avoid working long time or on deep coils
3	Professional high bar pressure	AHU cleaning for 4/6/8+ rows, extra accessories help other works	Avoid rotojet nozzle, low angle spray
4	Vacuum cleaner	For removing and collecting loose dust, debris	Avoid blower sending contamination inside the coil

It is essential to have the right size gun and various accessories to support the operation:

- Aerosol type pressure spray is a must to reach deep in the coil, without damaging the fins.
- Built-in chemical tank or suction line, for easy spraying of chemical.
- Lightweight and easy mobility.
- Easy operability; spray should be in aerosol form and should not damage the fins even when working 'point blank'.
- Extra accessories can be: curved lance to help work at inaccessible areas like heights and angles, mechanical tube cleaner to help clean soft internal tube scale and drain soft deposits, turbo jet to clean hard surfaces, etc.

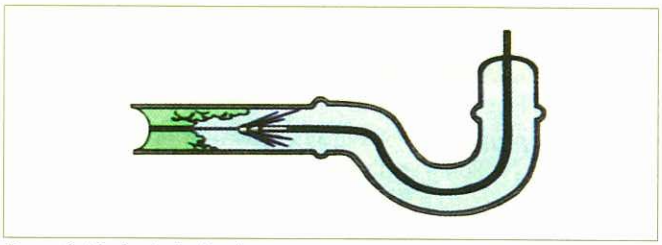


Figure 3: Mechanical tube cleaner

Figure 4: Curved lance

Hobby pumps should not be used in lieu of professional pumps. The former are used for cleaning hard surfaces like, sidewalks, bikes, cars, etc. Their long gun with high pressure and high water flow can easily damage the fins permanently, when working in inoperable situations.

Selecting Coil Cleaners

Any cleaning operation ought to be a combination of mechanical and chemical cleaning. The latter softens the contamination, and the former flushes it out from the three dimension coil. The ideal chemical should be eco-friendly, bio-degradable, non-toxic to human beings and metal safe. It should act only on rust, scales, oxides, oil and grease and be safe on metal, paints, plastic and rubber. It should conform to relevant international standards (US MIL, Ford, RoHS etc.). If it is compact (high dilution ratio of 1: 20/50/80/100 with water against 1:2-4 of ordinary chemical cleaners), it would save storing and hauling costs.

Choose a product suitable for the application: acidic, alkaline, neutral, water based solvent (degreaser) or bio-growth controller. *Table 2* compares the commonly used cleaners.

Table 2: Types of chemical cleaners

S. No.	Type	Where to be used	Precautions (always follow supplier's instructions)
1.	Acidic	Condenser coils, fin brightening	Be careful to use inside house; use protective gear
2.	Alkaline	Condenser/cooling coils/removal of oil-grease-deposits	Avoid residue in coil; use as per suppliers instructions
3.	Bio-growth controller	Should kill major bio-growth	Strictly follow supplier's instructions
4.	Water-based solvent	DG radiator cleaning, safe on copper tubes	Follow supplier's instructions; give sufficient reaction time

Coil Cleaning Frequency

Coils working 24x7, kitchen coils, etc. require more frequent cleaning than coils working 8-10 hours. Factors to be considered include filters getting dirty, coil surface getting dirty, complaints for low cooling, etc. The frequency may range from a 15 days cycle to 2-4 cleanings per annum. Filter cleaning frequency should be more frequent – maximum 7 days; such cleaning with a pressure pump will be more effective.

Coil Cleaning Operation

Once you have the professional equipment and suitable chemicals in your arsenal, coil cleaning is a simple operation. Generally professional equipment are easy to use and do not require any additional training. Choking of 4-8 row AHU coils is a major source of complaint and if they are attached to a kitchen, banquet hall, 24 hour coffee shop or 24 x 7 IT office, bio-growth is very frequent, if not professionally cleaned. If the bio-growth colony fully covers the coils, they literally turn 'coil dead'. Several installations are changing AHU coils every 2-3 years due to such problems.

Procedure

- Switch off the unit from the mains and ensure electric points and items are safely covered.
- Ensure drains are open and do not forget to clean drain pan while wrapping up.
- Read pump operating system and chemicals handling correctly. Dilution should be done as per manufacturer's guidelines and site need. Running water source near coil is a must.
- Vacuum dry dust if possible; do not try to push dry dust in the coil which may make your task more difficult. (Vacuuming is preferred, to remove dry-loose dust prior to plain water cleaning, if equipment is available). Plain water jet cleans 80% of coil dry contamination and needs to be cleaned at this stage.
- Try to clean the coil against the flow of air, so contamination is pushed out easily, especially for 4+ rows coils.
- Chemical application can be carried out by a normal spray bottle pump used in salons, or through pump tank/chemical inlet; mixing of chemical and water is controlled from gun nozzle by pulling it out – when pushed in, only water flows; chemical does not flow through the pump, but gets mixed near nozzle. Advanced pumps have a chemical flow controller.
- Chemical spray should be in fine penetrating mist form, in variable angles. Allow working time as per supplier's direction. Chemicals should penetrate thoroughly, in fine mist/spray form, thereby avoiding damage to the fins and to avoid excess chemical use. Chemical cleaning is preferred to remove oil, grease, grime, solid dust, chemical deposits, bio-growth or any other contamination. During bio-growth cleaning, goggles,

Figure 5: Cleaning in a tight space with low pressure and low water flow

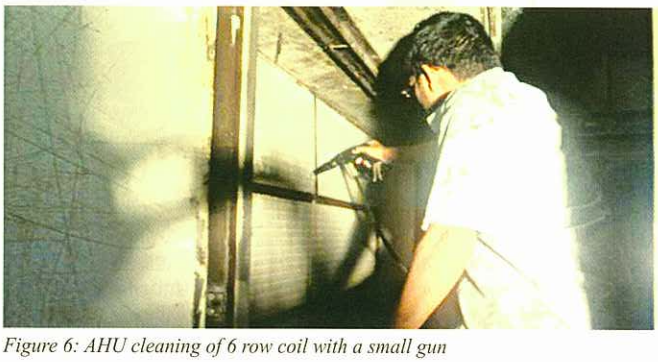


Figure 6: AHU cleaning of 6 row coil with a small gun

Figure 7: AHU coil cleaning at back side

Figure 8: Mist spray of a small comfortable gun hitting an air cooled chiller coil at 90°

protective mask (N-95) and other protective gear should be worn.

- Flush clean with plain water pressure wash. This job has to be done for a long period, since deposits will come out slowly from the three dimensional coil structure. Heavily choked coil needs continuous cleaning operation for long periods.
- Repeat the process, if required.

What Happens when AHU Coils are Cleaned?

- Initially no water will come out from the other side of the coil, while a lot of dirt will be seen coming out from bottom.
- After some hard cleaning there will be a burst of water coming here and there on the back side of coils, showing the coil is slowly opening up.
- Later, water will come out continuously and slowly; when the coil is deep clean, water coming out from the bottom will be clean, and from the back side it will just come out slowly and continuously.
- Heavily choked coils (near 0 cfm, 4+ rows) take approximately 2-3 days of intense cleaning. It is possible to clean fully choked coils at site with professional deep cleaning. Fully choked split and window AC coils can be cleaned in a shorter time.

Reasons for Poor Coil Cleaning

The author has observed, in the course of his professional work, a large number of sites where coil cleaning was poor because of the following reasons:

- Low budget for coil cleaning.
- Inadequate time for coil cleaning operation, up to 2-4 hours per quarter; 24 x 7 working coils require 6-8 hours cleaning per month.
- Improper equipment, wrong chemical choice, non availability of chemicals, e.g. bio-growth cleaner. A new Mumbai based 7 star hotel had to change coils within two years of operation due to mold formation.
- Bad water quality; fluorides, ions, chemicals and detergents can cause pitting and/or coil leaks, which may allow growth of scale leading to the insulation and bacterial growth.
- Site difficulties: At a 5 star hotel, medium sized AHUs were hung from the ceiling in a foyer to save space. At some other sites, one needs to crawl to reach the AHUs. There is no provision for cleaning water and drainage near AHUs.
- Condenser coils installed in a building duct are often covered with bird droppings and feathers, which produce corrosive gases, affecting brazing joints.
- Wrong filter installation allows air short cycling and access to lizards, cockroaches, etc. Regular filter cleaning with pressure pump and water is also a must.
- At a pharmaceutical site, absence of AHU drain trap allowed cockroaches to roam freely in AHUs, which brought hungry lizards in for their feast, leaving carcasses all around the sterile area.
- Lack of knowledge: A maintenance head told me that new coils do not require cleaning for the first few years; they had to replace a majority of the coils within two years of operation.

Some Good Practices

- Choked condenser coils are a major source of cooling complaints and compressor failures during peak summer months. One may use plain water cleaning with a suitable high pressure pump. Chemicals are required only when deposits of oil, grease or scales are found.
- 24x7 working 4+ row cooling coils, coils serving R&D labs, beauty parlors, textile showrooms, pathology labs, multi cuisine restaurants and laundries have heavily contaminated air, and cleaning should be frequent and intense in such situations.

Figure 9: Professional deep coil cleaning restores 6 row coils to original condition

continued on page 12

manufacturer. Manufacturers give COP rating for the units. kW/TR can be calculated from water flow, evaporator chilled water temperature difference and power consumption in kW.

The measured kW/TR can be trended against plant load in tons of cooling, outdoor temperatures and condenser water temperature. The resultant information can be a useful tool in maintenance programming; an increase in kW/TR may signal a need for maintenance or an imminent equipment failure. For example, an increase in kW/TR may indicate dirty condenser tubes in the chillers or a partially clogged strainer for tower pumps.

kW/TR = kW × 24/ Q × (T2-T1)

where

kW = kW inputs to chiller plant equipment used in generating chilled water,

Q = chilled water flow in gpm,

(T2-T1) = return temperature, T2, minus supply temperature, T1, in Fahrenheit for the chilled water entering and leaving the plant.

If kW/TR is higher than that specified by the manufacturer, appropriate action must be taken to correct it.

Conclusion

Adherence to the checklist for installation check and post start check will ensure optimum performance of the system and minimise power consumption.

Coil Cleaning in HVAC Systems - *continued from page 7*

Figure 10: Mold cleaning in the tray after deep coil cleaning

- Generally the coil cleaning job is outsourced. It is important to ensure proper supervision, check and compare data before and after cleaning. Identify coils as per usage, contamination deposits and then plan cleaning frequency on need basis.
- Pharmaceutical companies need to be sensitive about the US FDA norms. This is generally a nelected area.
- Coil cleaning can be reduced if the fins are chemically coated whereby their smooth surface does not allow contamination build up and is washed away with condensate water.
- Mold grows anywhere, and only requires water and food particles to grow. It is carried as pollen particles through air, starts growing in 48 hours and grows up to 28 lakh cells per night, as per published data. Choked wet drain pans and improper cleaning are some of the major causes of resistant mold. Staff should be trained to check vigorously for mold, and while cleaning should wear protective mask (N-95). Cleaning should be very intense with right chemical and pressure pump. Dead cells are also dangerous to human beings. See *Figure 10* and *11*.

Figure 11: Effects of mold

Conclusion

Air carries heat, moisture, contamination and viruses, apart from other things that get deposited in the HVAC system. Energy consumption and IAQ are severely affected due to poor cleaning practices. Since people are now staying more indoors (office and home), their health is affected due to HVAC pollutants. Coils have to be deep cleaned or they may be permanently damaged. Mold and bacteria can multiply in a poorly maintained system, posing health risks like asthma, nausea and more.