

Microbial Contamination IN HVAC SYSTEMS

Mr Jeremy Stamkos

Managing Director – Enviroair Pty Ltd
NADCA Certified Air Systems Cleaning Specialist (USA)
IAQA Certified Mould Remediator (USA)

ABSTRACT

The article “Microbial Contamination in HVAC Systems” has been written to inform people as to some of the critical issues that mould in built environments present. The occurrence of Microbial Contamination in HVAC Systems is common and is caused by many contributing factors.

Microbial Contamination within HVAC Systems may carry with it many associated risks from mild Building Related Illnesses up to and including death. It is not only the detrimental effects on health that microbial contamination causes, but it may also lead to significant system performance deficiencies and excessive energy consumption and property damage. Litigation from cases related to Mould Contamination within the built environment are dramatically increasing in the USA with Australia certainly following suit.

The importance of carrying out proper remediative action for a microbiologically contaminated HVAC System is of vital importance. The effectiveness of the remediation works and the engineering controls implemented to facilitate the remediation process will determine the likelihood of contamination reoccurrence. The duty of care to ensure that a HVAC system is free from significant microbial contamination may ultimately fall upon those responsible for the maintenance of the system.

Likewise, ensuring that a contaminated system is remediated correctly fall’s upon not only the contractor carrying out the remediative works but also those who employ their services.

Microbial Contamination in HVAC Systems (cont.)

Excessive energy consumption, costly property damage, litigation and building related illnesses are just some of the potential effects of unchecked microbial proliferation in HVAC Systems.

Due to greatly publicized out breaks over the past few years, much attention has been given to the control of Legionella in our buildings water systems. However, as recent case studies in the US are revealing, litigation over other forms of microbial contamination in buildings are attracting the attention of many building owners and Facility Managers.

Fungal and microbial proliferation within AC Systems has the ability to dramatically reduce the systems operating efficiency whilst significantly increasing the systems operational costs.

As fungal and bacterial growth proliferates throughout certain components of the AC systems, airflows are restricted, pressures within the system increased and delivery of conditioned air into the occupied areas may be dramatically reduced.

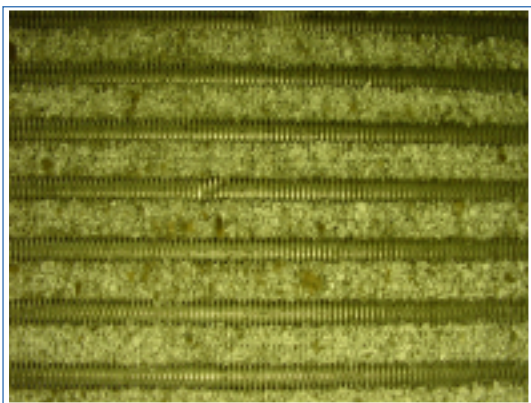
Aside from the excess operating costs of an AC system harbouring significant microbial growth, the costs of remediating a contaminated AC system and or property affected by the spread or fallout of contamination can be devastating. The costs to remediate an AC system found to harbour microbial contamination may be up to ten times that of general HVAC cleaning depending on the extent and severity of the contamination and if system components can be remediated or need to be replaced.

The subjects of Indoor Air Quality, Sick Building Syndrome and Building Related Illnesses may be a bane to many building owners and managers nowadays with many services providers and sales people eager to promote their related products or services. However, when cases of microbial proliferation occur within a building and particularly the AC systems, the importance of these subjects have significant relevance.



The same coil after Decontamination

Over the last few years, there have been many successful cases of litigation against insurance companies, building owners, managers and service providers resulting from negligence in dealing with microbial contamination incorrectly. Opinions within the property maintenance industry regarding the prevention, identification and remediation of microbial contamination vary greatly as very few professionals are well versed on the subject.



The Heavily Contaminated Heating Coil

One thing that is for sure is that people who have had exposure to the detrimental effects that unchecked microbial contamination may cause are generally great advocates of taking proactive or preventative approach to HVAC system cleanliness.

Microbial Contamination in HVAC Systems (cont.)

Increases in Relative Humidity within an AC system may be caused by things like poor system design, poor manufacturing/installation, damaged heating and cooling coils or outside weather conditions. The poor design of undersized or ineffective condensate pans and drains may contribute largely to high humidity within many AC systems.

The neglect to install adequate dehumidification especially in the more tropical regions may also lead to high humidity within the AC System.

Pinhole corrosion and other forms of damage to coils may lead to higher than normal humidity within the AC system. When a Cooling coil is leaking substantially, the amount of water in the condensate tray is often more than it is designed to drain and subsequently causes excessive water activity in and downstream of the AC plant. In several systems that had full condensate pans, the humidity within the supply air ducts downstream of the AC plant been measured in excess of 90% RH.

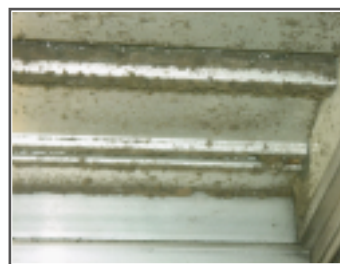
When a Heating coil has deteriorated, corroded or been damaged to the point where a water leak develops, the probability of microbial proliferation is quite high. As heating coils do not generally have any provision for drainage, the water may accumulate within the duct, dramatically increasing the level of humidity. With the increase in humidity created from the leaking water, it does not take long to create the ideal environment for mould to start growing.



Cooling Coil completely blocked with fungal "cocktail". Negligable air was able to pass through this coil.

Even though the most common place to find mould growing within an AC system is on the coils, filters and condensate pans, in severe cases it may be found throughout the entirety of the system. Volume Control and Fire Dampers, Rigid Ducts both internally insulated and not, aluminium and plastic Flexible Ducts have all been evidenced as being significantly contaminated with fungal growth.

Microbial contamination within an AC System at any level may have the capacity to have costly ramifications.



<< Mould growing on Smoke Dampers



<< Mould growing on internal insulation

Operating Deficiencies

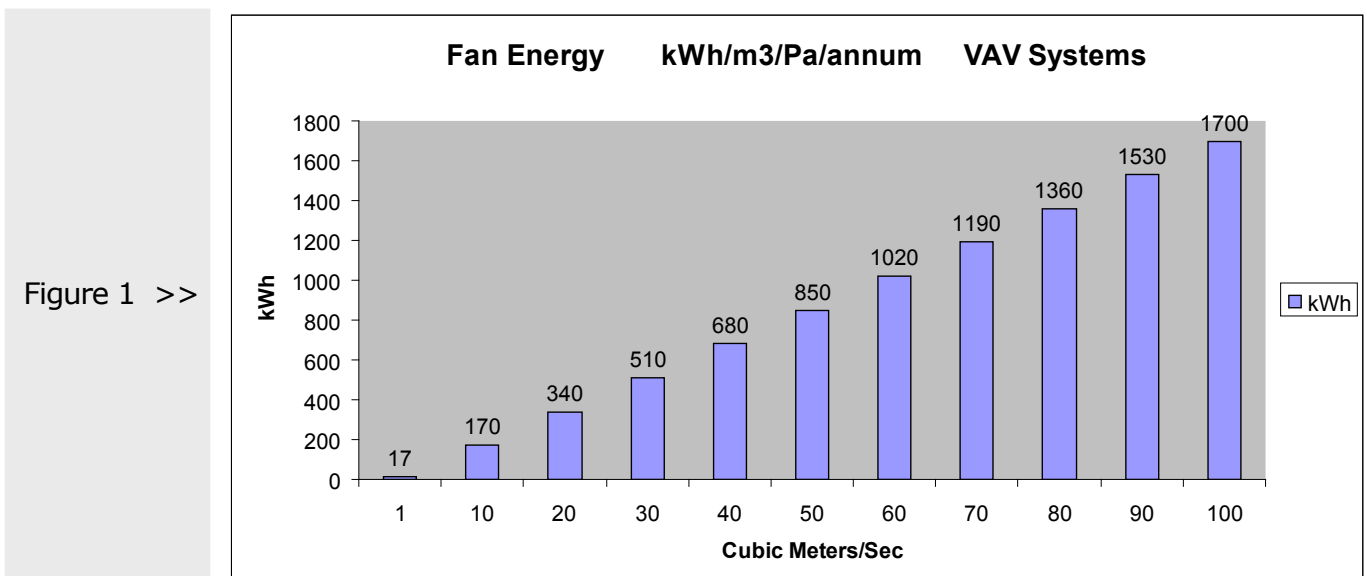
As key components of the HVAC system become contaminated with micro-organisms, the operating efficiency of the mechanical plant reduces dramatically. This can lead to reductions in thermal efficiency of the heat transfer of coils thus increasing compressor loads and extending running cycles.

Figure 1 (below) depicts the energy required to move air through inline resistance. Coil and filter resistance is commonly referred to as pressure drop with the Pascal being the common measure.

An extensive study of energy efficiency in air filtration (NUTEK 1997) reports that each 1m³ /s per 1 Pa / annum at a 50% fan efficiency requires 17 kWh fan energy.

Hence the lower the average system resistance over time the less energy required. Fouled coils can add significant resistance to the air handling system.

Fungal proliferation in air filters also adds unnecessary resistance to the system causing reduced service life and increased fan energy requirement to maintain supply duct and conditioned space values.

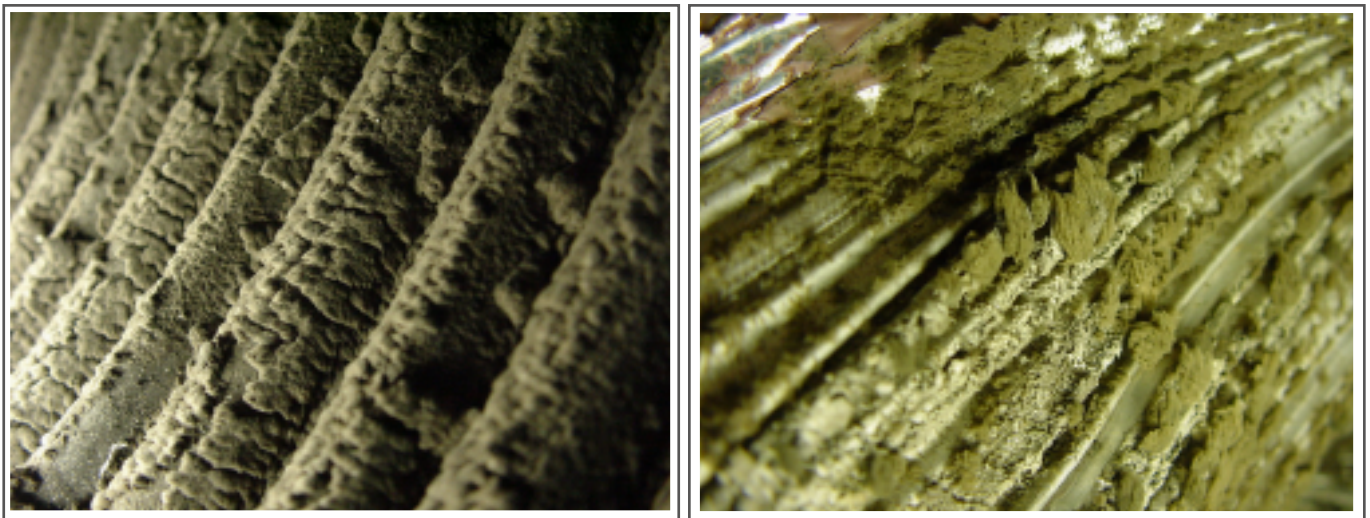


Research findings indicate that coil fouling alone can add up to 100Pa above design specifications to the system. In a larger VAV system required to move an average 40m³/s with an artificially elevated resistance of 50 Pa this equates to \$ 1,664.00 per annum based on .10c per kWh and a 12 hours per day run time.

Property Damage

The detrimental affects of fungal growth within an AC System may range from a small component requiring cleaning and treating to the entire building being condemned. The costs for proper mould remediation of an entire AC System are generally quite considerable let alone the loss in productivity or other costs associated with the remediation works.

Many types of mould that are commonly found in HVAC systems are corrosive and/or destructive and have been found to cause considerable damage to internal metal and insulated surfaces. In extreme cases, mould can be so severe that the operation of Dampers, including Fire and Volume Control, and other internal components has been compromised.



Two examples of mould growth found within plastic flexible ducts

In a recent case in the Northern Territory, a building that was no more than four years old had such severe microbial contamination, that the building was condemned whilst the remediation works took place.

The total of the restoration bill was in excess of \$1,400,000.00 of which less than 10% was the remediation cost of the AC system. A comprehensive HVAC Hygiene program for a building this size would not even equalled \$1,000,000.00 in more than thirty years.

After severe fungal growth has been able to lay siege to a building or it's AC System, many components may need costly repairs or replacement.

In 2002, a Melbourne building that was found to harbour severe fungal growth throughout its AC Systems on three floors. The system was a high velocity, dual duct system with approximately twelve Mixing Boxes on each level. The fungal growth was so severe on the internal fibreglass insulation within the Mixing Boxes and attached Attenuators, they had to be disassembled and taken off site for remediation.

When fungal growth is this severe in components like these, generally replacing them is a more cost effective option. Unfortunately, in this particular case, the components were approximately 40 years old, obsolete and no replacement parts available.

The total remediation cost of the AC Systems that serviced the three levels was over \$80,000.00 compared to \$18,000.00 which would have been the cost for normal cleaning if the mould was not present.

Health Effects

Microbial spores are analytically identifiable on nearly all indoor and outdoor surfaces and also in the day to day air that we breathe. For most of us who are generally healthy, this level of exposure to these microbial spores has no significant impact on our wellbeing.

Certain species of common indoor moulds are known to release toxins and in high concentrations have the capacity to cause a negative impact on a person's health.

Much research is being done at this time on the toxicity of some of the moulds commonly found within our buildings Air Conditioning Systems.

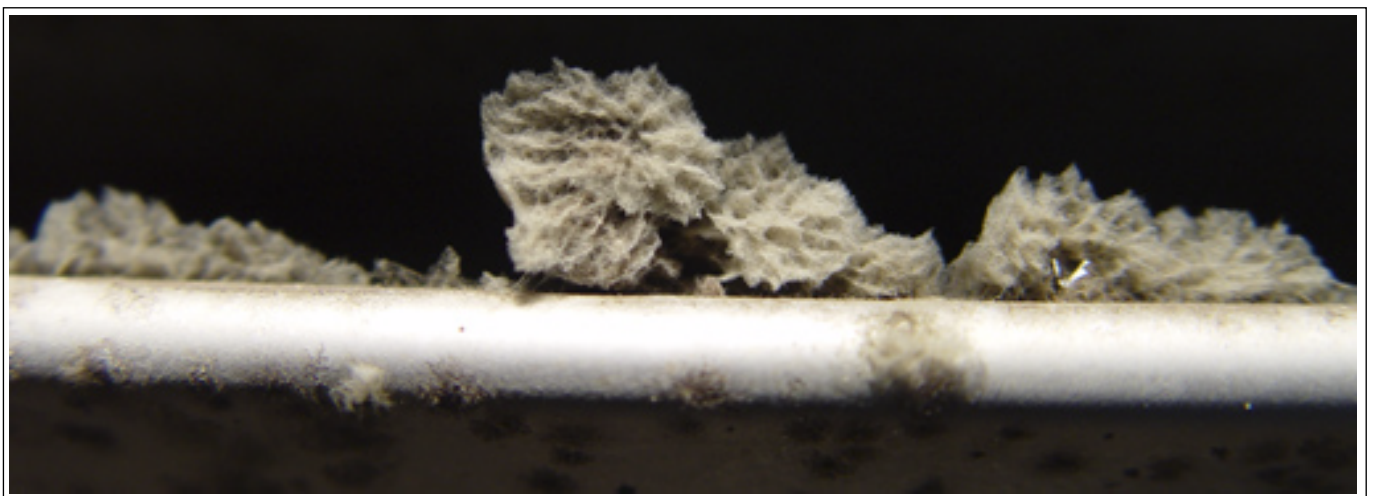
Studies have confirmed that when fibreglass insulation materials and painted metal surfaces become colonised, VOCs such as Hexanol, 2-Cyclohexen-1-ol, 2, 3, 4-Trimethyl hexane, 2-Butyl-1-octanal, 2-Pentenal, Ethanol, Acetone, methyl benzene and various other compounds have been isolated.

As Air Handling Systems in buildings can provide an excellent environment for the proliferation of bacteria, fungi and mould. As these micro-organisms metabolise, a range of bacterial and fungal by products and minute organic fragments are dispersed and recirculated within the indoor environment. These breakdown products are known to induce a range of health complaints including allergies, immune suppression and respiratory ailments, along with low-level irritations, headache and fatigue.

"Sick Building Syndrome", as it has come to be known, affects a large majority of commercial buildings globally. It results in many Building Related Illnesses which may cause measurable declines in staff efficiency, increased absenteeism and reduced occupant wellbeing.

Microbial contamination within an AC System is usually identified when a diligent tradesperson is conducting routine maintenance and brings it to the attention of the tenant or building manager. Unfortunately, in most cases, not much action is taken unless a significant number of the buildings occupants are claiming to suffer from symptoms caused by Building Related Illnesses.

Building Related Illnesses are a direct result from Sick Building Syndrome which at many times may be directly related to a Buildings Air Conditioning Systems. Many professionals that are called in to try to identify the cause of the Building Related Illnesses don't consider inspecting the buildings Air Conditioning Systems for the cause or source of the problem.



Mould colonisation within a HVAC System

A Proactive Approach

Periodic inspections of air handling plant especially in any areas of likely moisture such as Humidifiers, Cooling Coils, Condensate Pans and drains are recommended to identify any potential causes of microbial proliferation. All components downstream of the filtration system should be relatively free from any significant visual contamination.

Maintaining a high level of HVAC System cleanliness is one way to reduce the risk of microbial proliferation. Routine cleaning of Return & Outside Air Ducts, cleaning and treating Cooling Coils and replacing filters prior to them becoming compromised is always good practice. Most buildings that have a highly maintained AC System rarely see significant cases of microbial contamination.

Many "antimicrobial" products are commercially available that claim to be able to kill or prevent mould within AC Systems. These products range from sprays and gases to sponges and gels. Caution and discretion must be used when considering using any of these products and treatments.

Many have associated odours with their application that may be evident throughout the manufactures claimed effective period. Consideration must be given as to whether it is desirable to have products that will for their life span, emit or off gas odours within the buildings ventilation systems.

Unfortunately, many of these products or treatments do not have reliable scientific data pertaining to their use in ventilation systems. Many of them will kill different types of mould on actual contact but have been proven ineffective when installed in ventilation systems.

However, there are some highly efficient antimicrobial products available on the market specifically designed for use in AC Systems. The most effective solutions usually come at a greater cost compared to most of the "do it yourself quick fix" type products, but are very effective in killing and inhibiting fungal growth within the AC System.

When choosing an antimicrobial product or treatment to use within an AC System, choose products that come from a company able to provide scientific documentation to support the claims of the products antimicrobial properties.

Only ever use products that are specifically designed for use in HVAC Systems. It is also best to find products that will offer a residual antimicrobial protection that will not cause secondary contamination issues.

Most importantly, ensure that the persons installing or applying such products or treatments are doing so in accordance with the manufactures instructions. Many claims are being made that buildings today are being managed proactively however, unfortunately a large amount of the time this does not extend to the Hygiene of HVAC Systems.

The costs of maintaining an acceptable level of HVAC hygiene is insubstantial compared to the savings in operational/energy costs, reduced risk of costly property or plant remediation and potential litigation.

About the Author

Mr Jeremy Stamkos is the Managing Director of Enviroair Pty Ltd. Enviroair is a company that has been specializing in the decontamination and remediation of Commercial and Industrial HVAC Systems since 1990. Mr Stamkos has been directly involved with the company since its conception and in 2001, he became Managing Director.

Many years of direct employment within the HVAC Cleaning Industry starting as a Technician all the way up to the current position as Managing Director ensures that Mr Stamkos' vast experience and qualifications in the industry are unsurpassed within the Australasian Region.

References

ANSI/ASHRAE 62-1989 : NUTEK 1997 : Crawford Adjusters Canada
Photographs supplied by Enviroair.