Microbial Problems in Buildings

A Building Hygiene and Microbial Prevention Program

Kim W. Strong, Technical Director
ÆGIS Environmental (Canada) Limited
Dartmouth, NS

ÆGIS™

Microbial Problems in Buildings

A Building Hygiene and Microbial Prevention Program

Kim W. Strong
Technical Director
ÆGIS Environmental (Canada) Limited

Contents

Acknowledgements

I have had, in my professional career, the pleasure of working with business partners who have allowed me the freedom to pursue my interests in the world of the unsightly, unwanted and unloved. In particular, I would like to thank Jim Edwards, the late Geoff McBeath, Tony Ramia, Ken Marvin, Doreen Chenard, Aven Cole, Kevin Bearnes and Scott Simms for affording me this priviledge.

However, one person has helped to incubate my interest more than the others - W. Curtis White of ÆGIS Environments in Midland, Michigan. Curt first introduced me over 10 years ago to the science of preventing microbial attack to building surfaces and has not stopped adding to this knowledge. This manual is dedicated to Curt - the Mr Spock of the starship *Indoor Environment* and my favourite mad scientist.

Section 1 - An Overview of Microbes

Bacteria and fungi are an integral part of our environment. Other than a very few highly controlled environments such as computer clean rooms and high-risk procedure medical facilities, we are surrounded by microbes.

The Fuzzy Gray Stuff

By definition, in their smallest form they are microscopic or too small to see with the naked eye. By the time they are large enough to see, you aren't looking at one microorganism, you are looking at hundreds or millions. At that point the question isn't whether or not you have microbial contamination. You do! The appropriate questions are: *How bad*? and *How dangerous are the organisms*?

In indoor environments, microbes are found on all environmental surfaces, in the air and in water associated with both normal and catastrophic situations. They may be growing there (called amplification) or may simply have been deposited there from elsewhere. The few highly publicised outbreaks of Legionnaires Disease and the more complex indoor issues of today such as Sick Building Syndrome (SBS) and Building Related Illness (BRI) have begun to put microbiologists and microbiological sciences in the headlines and on the line.

Microbes in indoor environments can cause all of the following problems:

Building Problems
- **odours**
- **corrosion**
- **staining**
- **deterioration**

Business Problems
- **higher insurance costs**
- **lost tenants**
- **lost productivity**
- **shorter renovation intervals**
- **higher maintenance costs**

Human Problems
- **irritation**
- **infectious disease**
- **sensitisation**
- **toxic responses**
- **discomfort**

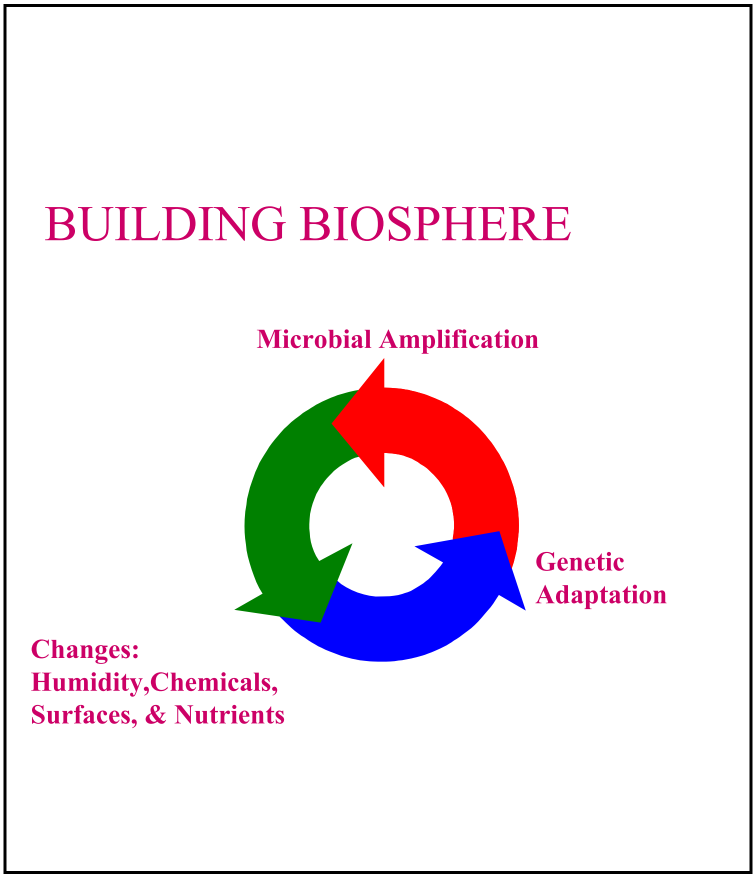
BRI Defined

Technically, BRI is defined as the clinical manifestation of occupant exposure to excessive airborne pollutants in a building. The array of typical symptoms includes headaches, burning eyes, fatigue, dizziness, flu-like maladies and upper respiratory complaints. Although these symptoms can by generated by many different things, all can be caused by microorganisms, and more and more frequently these microbes, especially fungi, are being implicated as primary and contributory factors.

The buildings in which these organisms thrive are not simple environments. They are complex ecosystems that are made even more complex by the constant change a building undergoes throughout its life cycle. Microbial contamination, in varied but inevitable ways, will occur at different stages of this life cycle and will be manifested in many ways.

The Building Biosphere

A building can be thought of as a biosphere with the organisms in a constant flux. Nutrient and humidity changes and alteration of life-limiting (toxic) surfaces allow microbes to adjust and often adapt to the ever-changing conditions in their environment.



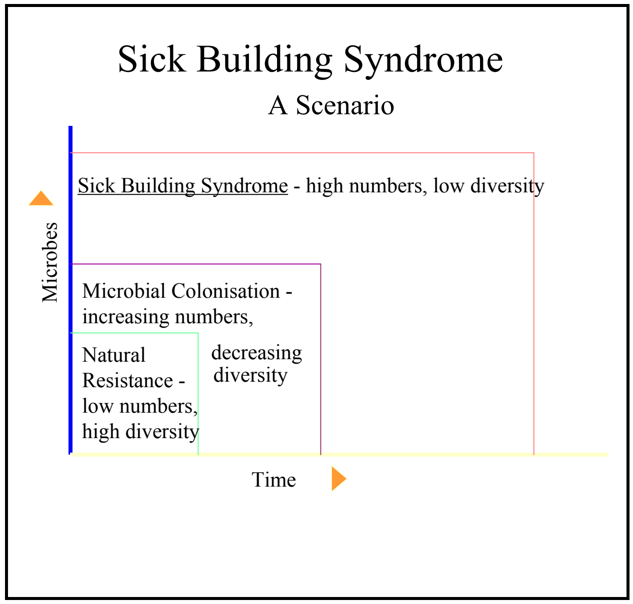
Associated with buildings and their inhabitants are the full range of microorganisms: bacteria, fungi, viruses, protozoans and algae. Each of these groups of organisms has its own niche and each fills a natural role in the microcosms of a building. No absolute methods exist for retrieval, identification or linkage of microbes found in buildings to many of the human symptoms that are presented.

Microbes are not as simple as the whole intact organisms we test, but, in fact, their somatic parts, reproductive parts and metabolites are all implicated as causative or potential human or building antagonists. Microorganisms are the only source that presents all forms of pollutants - particulates, gases and infectious biologicals. They are particularly potent in that they can amplify and cause the full breadth of discomfort, irritation, sensitisation, toxic reaction and disease that we associate with indoor environmental quality.

What Causes Microbial Growth?

The microorganisms represented in a building are complex. Every element of a building, its furnishings and its people, offers a home for microorganisms. Microorganisms need moisture and nutrients and more than 95% of them need to be associated with a surface.

Moisture can come from catastrophic or normal events - a leaking roof, a sweating pipe, a leaking radiator, condensation on windows, condensation on more subtle surfaces where dew points are reached, humidified air from the HVAC system or any of hundreds of other sources. A hotel or condominium facility compounds the problem with the moisture from pools, spas, individual air conditioners and literally hundreds of bathrooms. This, coupled with wall to wall carpeting, draperies, wall coverings, furniture, bedding and ceiling tiles, creates ideal habitats for microorganisms.



During the life cycle of every building, conditions will change - such as by flooding - that will favour the growth or amplification of microbes.

Nutrients utilised by microorganisms can be organic material, inorganic material and/or living tissue. For example, bacteria play an important role as part of the body's microflora and, alone and with skin, are shed continuously. Given acceptable growth conditions, some types can multiply from one organism to more than one billion in just 18 hours.

A building may be infested during construction and after catastrophic events (particularly with fungi), but more commonly the organisms are routinely brought into the building by its occupants or air infiltration routes. Fungi (typically outdoor organisms known as mould, mildew, and yeasts) enter the building on clothing, are wafted in through open doors or are pulled in as make up air by the HVAC system. Bacteria follow these same routes but are primarily associated with human carriers and with very wet areas such as drain pans and places with constant or standing water.

Airborne Pollution

Although most organisms grow on receptive building surfaces, they and their spores become airborne through normal occupant traffic and activities such as vacuuming. Once airborne, the HVAC systems, chases and elevator shafts efficiently transport the microorganisms throughout the building. They settle on other receptive surfaces and quickly begin to reproduce. One good growth source for a particular organism can quickly result in outbreaks in every part of a building.

Also, with the almost universal use of air conditioning, recycling air to improve energy efficiencies takes place. Yet, that recycling tends to concentrate indoor air pollutants including microorganisms and their annoying, irritating, sensitising and toxic by-products.

Additive or Synergistic Effects

Partially because of the common failure to find definitive causes for sick buildings, the additive or synergistic effects of particulates, gases and microorganisms have come under increasing scrutiny. The short-term symptomatic relief achieved by control of microbial growth sources is strong evidence that most building health problems are not created by a single pollutant.

Numerous case histories show that reports of human SBS symptoms have dropped dramatically or ceased in buildings where levels of airborne microbial contamination have been significantly reduced. This is true even where no single species of organism has been identified as dominant and, indeed, even in buildings where testing could not confirm that microbes were even a problem.

Pollution problems and their effects on energy efficiency and human health are clearly generated from the complexity of our buildings, occupant habits and practices and the potency of individual and combined pollutants.

The Good, The Bad and The Ugly

The number of types of microbes that can be found in building environments is overwhelming. Nonetheless, the practical list can be reduced in scope to include these commonly found types, most of which are fungi.

Aspergillus species
- *A. versicolor*
- *A. ustus*
- *A. niger*
- *A. flavus*
- *A. fumigatus*
- *A. sydowii*

Penicillium species
- *P. chrysogenum*
- *P. crustosum*
- *P. brevicompactum*
- *P. aurantiogriseum*

Cladosporium species
- *C. cladosporioides*
- *C. sphaerospermum*

Alternaria alternata
Ulocladium chartarum
Fusarium species

Aureobasidium pullulans
Stachybotrys chartarum
Epicoccum nigrum
Rhizopus species
Mucor species
Chaetomium globosum
Chrysonilia sitophila
Phoma glomerata
various sterile isolates
various type of yeasts

Legionella pneumophila

This list is not complete - it is not even a major part of a total list. However, if routine samples are collected in problem and non-problem buildings, these sorts of organisms occur in samples over and over again.

Some of these organisms, such as *Cladosporium cladosporioides* and sterile isolates (often from mushroom spores), are common in air samples collected in outdoor air as they grow easily on leaves, grass and other vegetation surfaces. In summer, numbers of spores in outdoor air can easily exceed 1000 colony forming units per cubic metre of air (cfu/m^3, see sidebar). Other species less common in outdoor air samples can become common in indoor environments, particularly if the environment presents suitable surfaces for colonisation. For example, *Stachybotrys chartarum* is seldom collected in outdoor reference samples but can, in certain circumstances associated with flood conditions, easily colonise wet cellulose (ie paper) surfaces such as drywall and become a significant and serious component of samples collected indoors.

Typically, air samples are collected and the spores that are obtained are incubated for 5-7 days. The colonies that grow - colony forming units - are counted and identified. In summer, routine air samples collected from air outside buildings may have in excess of 1000 cfu/m3. In winter, the concentration may be undetectable due to snow cover.

Ideally, concentrations of colony forming units in buildings ought to be no greater than in outdoor air and the kinds of organisms that are collected should be similar. In winter, with nothing in outdoor air, most buildings will have more growth than found in samples collected in outdoor air.

The important factor is the species diversity - some species are relatively common in buildings and others should simply not be there.

Section 2 - Causes Of Microbial Contamination

The presence of excessive microbial growth in a building (with ***excessive*** being sometimes simply a synonym for ***unwanted***) is the result of any one or combination of three separate causes:

Disasters -	flooding, leakage, pipe breakage, etc
Poor Environmental Control -	excessive relative humidity, poor building maintenance and construction practices
Normal Conditions -	dampness in shower areas, garbage bins, dampness in ventilation equipment

In reality, all microbial contamination in buildings is ultimately derived from microbes brought in from outside. There is no such thing as spontaneous generation. However, many building materials - such as drywall and other manufactured products - come "pre-innoculated" with viable spores, meaning that microbial growth can be initiated immediately upon the addition of moisture.

Disasters

Disaster conditions can result in uncontrolled microbial growth. Frequently, the types of species that dominate such environments include both highly toxigenic and pathogenic varieties - *Stachybotrys chartarum*, for example, commonly grows on wet drywall paper following flood conditions.

All receptive surfaces in the building that are subject to direct wetting will become colonised if they remain wet for long enough and, after a short time, other surfaces in the building that have been exposed to the humid conditions that follow the disaster will also be colonised, normally by an at least partially different group of organisms. Some of these are as equally unacceptable in indoor environments as those that grow in the areas of direct wetting.

Immediate control of the disaster conditions is required to prevent microbial destruction of the environment. Restoration firms are well aware that drying must be implemented within 48 hours and be complete within 96 hours or else major restoration, done under carefully controlled conditions, will be necessary.

Disaster restoration is a thankless, disruptive, dirty and expensive business. It is like wrestling with a pig - everyone gets dirty but only the pig likes it. Typically, disaster restoration involves removal and replacement of flooring, wall coverings and most furnishings. Workers and surrounding uncontaminated areas must be protected from exposure to spores, body parts and chemical metabolites of the many types of fungi and bacteria that thrive in such conditions. Given the ability of water to penetrate into all available areas, microbial contamination is often discovered after the restoration was thought to be complete. This creates the ideal environment for litigation, a compelling reason to prevent microbial contamination if at all possible.

In the past, insurance firms typically provided insurance coverage for disaster restoration, including the cost of cleaning up mould growth. However, on the down side, the firms doing the cleanup seldom had any education in doing this, often consisting of little more than general untrained labourers with a few skilled trades persons. More recently, insurance firms require restoration contractors to have significant training in microbial remediation but, unfortunately, they now generally explicitly exclude all forms of mould growth from coverage. In short, they cover only the water loss component of disasters. Mould growth that results from water loss is not covered, mostly due to the seemingly simple fact that microbial growth can be prevented if water is cleaned up quickly. Generally, this is academically correct although it often happens differently in the real world of “Murphy’s Law”. This clearly puts an onus on the building owner to implement programs such that microbial growth is minimised. However, building science has not generally changed the construction methods appreciably to provide much help. If it gets wet, it will generally support growth.

Houses are still built using a large amount of paper or “wood soup” and even toothless, weak and old mould can eat paper.

Poor Environmental Control

Microbial growth does not require flooding or even direct wetting of surfaces to initiate. Simply allowing the relative humidity to remain above 65% for extended periods of time will initiate growth. Every basement in every house that smells like dirty socks when you walk down the stairs is evidence of this.

Common situations that permit mould growth include:

- lack of meaningful dehumidification in below grade environments
- carpeting laid directly on concrete slabs-on-ground (on- and below-grade)
- construction during humid summer conditions without sufficient ventilation
- installation of drywall before buildings are water-tight
- Inadequate drying and control of relative humidity in non-water damaged areas of buildings following flooding

Many building materials, including drywall and fabricated wood products, are very hydrophilic and will readily absorb water from the air when the relative humidity is suitably high. In most buildings with insufficient ventilation, the highest humidity will be near the floor and cold exterior walls. These conditions are exacerbated by storage of materials and placement of furniture near these walls, which reduces air flow and allows even cooler conditions and higher humidity to develop.

Unfortunately, basements are often used for storage, have limited ventilation, are prone to leakage and are seldom dehumidified. This is a receipe for mould growth, especially in residential environments.

The choice of building materials is also a factor. The increased use of manufactured wood products and use of paper-surfaced drywall creates environments perfect to support mould growth. Remember that even the stupidist of the three little pigs didn't build his house out of paper! Efforts to control heat loss by reducing the amount of fresh air further compound the problem.

Remediation of these econditions, like disaster restoration, generally involves disruptive practices and substrate removal, all under conditions to contain dust and protect workers.

Normal Conditions

Certain conditions in buildings are normally conducive to microbial growth. Some of these environments include:

- garbage storage areas and composting containers
- foyers and other entranceways that receive foot traffic
- spas, showers, locker rooms and pools where moisture is simply inevitable
- bathrooms, especially in hospitality buildings
- interior surfaces of air conditioners
- processing machinery that uses water
- eviceration plants and similar areas where daily washdowns are required
- greenhouses
- compositing and recycling facilities (see sidebar)

In these areas, dealing with water may be essentially impossible. At the very best, extreme diligence is required to remove excess water immediately. Yeast-like organisms thrive in such environments. In composting facilities, risk control is essentially an exercise in worker protection, as the elevated temperatures and continuous supply of organic matter permits unrestricted (and intended) microbial growth.

> Composting facilities provide perfect incubation for pure cultures of *Aspergillus fumigatus*, causing airborne spore concentrations to exceed 2500 per m^3

Section 3 - Remediation

Traditional Solutions

Mould and mildew have been recognised for years as a major cause of problems in buildings, although most of the recognition has focused more on odours, rot and unsightly growth rather than on human health problems. Management has struggled valiantly (but with minimal success) against mould and mildew in an effort to provide a clean, pleasant and safe environment. There has been an unending array of products, cleaners, chemicals, devices, strategies, and methods available to combat microbial problems from mildew to pathogenic bacteria. Some have offered limited success and some are simply dangerous.

Housekeeping procedures: Housekeeping professionals regularly scrutinise building spaces and remove any visible growth. Detergent/sanitiser products are effective short-term tools against visible mould and mildew, but some areas require harsh bleach or mildew removers. All are short-term solutions and many of the products present their own toxicity problems.

When musty odours develop, cleaning personnel frequently use perfumes and fragrances to mask or disguise the problem (and the often-offensive odours of the sanitisers). These can create more of a problem than they solve for allergic and sensitive individuals. The hospitality industry deals with this daily.

Engineering procedures: Most tactics in this category include selection, operation, modification, and maintenance of HVAC systems to permit better temperature and humidity control and better filtration. This does not address microbial infestation or eliminate growth sources, but it can reduce the rate of growth of mildew. However, it may result in dramatic increases in microbial growth within the air handling equipment itself.

The air handling and engineering specialists have worked with filtration and extraction of pollutants but have generally concentrated on dilution. Recognising that the severity of virtually all human toxic response is based on a combination of toxicity and dosage, the theory is that dilution of an environment with massive amounts of fresh air lowers the dosage level below the human response threshold and eliminates the problem.

The initial modern attempt was ASHRAE's (The American Society of Heating, Refrigeration and Air Conditioning Engineers) Standard 62-1981. That standard established an optimum ventilation rate of 5 cubic feet of air per minute per person (cfm/person). Since this significantly diluted the concentration of pollutants in the air, immediate human health benefits were usually noticed. Unfortunately, since the pollutant sources were not being addressed, the health problems frequently returned. This was particularly true where the primary pollutant was microbiological. Chemical pollutant sources tend to be static or reducing over time, but microbial sources continue to grow and increase in output of toxins.

The answer to the deficiencies of ASHRAE 62-1981 was ASHRAE 62-1989 and then ASHRAE 62-1999. These moved the Standard to a range of 15 cfm/person to 20 cfm/person in general office spaces. They also assume a maximum occupancy of seven persons per 1000 square feet.

As before, implementation of the standard produced immediate health and comfort benefits for occupants, but continuing problems in our modern buildings show that this dilution strategy does not address the real problems of indoor environmental quality. A secondary problem is that the added energy costs associated with dilution strategies, when combined with their failure to address pollution sources, raise serious cost/benefit questions.

Industrial hygiene procedures: Most industrial hygienists, schooled in chemistry, testing and toxicology and reinforced by the public's chemophobia, have challenged the importance of added fresh air and have concentrated on identifying and removing and/or containing sources of pollutants (chemicals) and routes of pollutant transmission. This focus has created an army of consultants and a very lucrative testing industry. Unfortunately, most authorities concede that the batteries of sophisticated tests and voluminous reports have been able to identify a specific cause in less than twenty percent of acknowledged sick buildings. In plain English, this means that, at the time of testing, no substance was identified that exceeded the generally accepted limits for the chemicals tested.

Although the presence of fungi or bacteria is commonly noted in reports, it seldom receives more than very general recommendations. The great majority of industrial hygienists do not have formal training in microbiology or mycology and they tend to ignore or downplay the possibility of microbial causation.

The above comments are not in any way meant as a criticism of industrial hygienists. It is simply recognition of the fact that people focus on areas where they are comfortable. Faced with literally thousands of different bacteria and fungi that range from beneficial to deadly, test methods that (when compared to chemical tests) have questionable reliability and reproducibility, a total lack of accepted standards, and today's fear of litigation, it is not surprising that industrial hygienists seldom venture into the complex world of microbiology.

After these methods have been tried, and microbial growth is clearly winning the battle, the next step is often serious remediation efforts.

Controlled Cleanup

In recognition of the newly emerging concerns about environmentally-induced illnesses, a number of science-based protocols focussing on remediation methods have been developed over the past half-decade. The most commonly used of these include those prepared by:

The New York City Department of Health
The United States Protection Agency
The Institute of Inspection, Cleaning and Restoration Certification
The Canadian Construction Association
The Canadian Standards Association

Of these, the New York City protocol is the most widely referenced.

> Unfortunately, few of these protocols seriously acknowledge that microbial growth is opportunistic - if we create the perfect environment the critters

All of them are variations of the same theme - the method to be used to control construction dust generation is a function of the amount of growth present. The CSA standard, prepared for health care facilities, also factors in risk associated with the nature of the work, the occupants and the types of microbial contamination that might be present.

Full scale cleanup methods, generally recommended for mould contamination covering more than 10 square metres (100 square feet), are disruptive and generally involve dust control, isolation of work areas and protection of work crews from exposure to microbial residues. The most stringent of the methods cannot be done routinely by building maintenance personnel. Trained contractors must be used instead. Unfortunately for some building owners, the training can be sadly lacking and may not be discovered until it is too late.

These protocols have, for the most part, been prepared starting with existing protocols for removal of asbestos, based upon the general assumption that microbial growth and asbestos are similar. They are not. Nonetheless, these protocols represent real progress in terms of trying to focus consultants, contractors, owners, tenants and the legal community to think in terms of a unified method.

Unfortunately, few of these protocols seriously understand that microbial growth is opportunistic - create the environment and the critters will come! This is the major difference between asbestos and mould - asbestos was put in buildings intentionally and can be removed permanently whereas microbes generally are not present (or at least are not meant to be present) in new construction but opportunistically appear with time. Building expertise has not caught up to scientific expertise. It is of little good to simply state emphatically that control of moisture is all that is needed to control microbial growth. Floods, pipe breaks, washing machine overflows, water heater bursts, broken windows, failed roofs and other similar events occur daily.

What is needed is a means to prevent or reduce the rate of growth even in the face of unavoidable occurrences. Prevention and reduction of growth has the advantages of:

- less exposure of people and belongings to microbes and volatile chemicals
- less disruption to work environments
- less expensive to prevent than remediate
- less construction waste at landfills
- better building performance
- consistent with insurance industry exclusion policies regarding mould growth

Amplification will not occur if all aspects of the building envelope can be controlled and maintained within ranges that do not support microbial activity. This can - at least in theory - be accomplished. In practice it cannot or, at least, has not - if it could be done it would have been done already.

The important question to ask is this - if these methods that we use now are so good, **then why haven't they solved the problem?**

Einstein once said that methods used to solve and prevent problems must be better than those used to create them. The following sections describe methods that meet this criterion.

Section 4 - The ÆGIS Microbe Shield

A Non-Traditional Solution

In 1969, researchers at Dow Corning Corporation discovered a unique way to attach biocidal agents permanently and directly to a wide variety of surfaces. The resulting non-volatile polymer is unique among antimicrobials in that it does not create a zone of inhibition and does not dissipate over time. This extraordinary technology permits the continuous, durable activity against mildew that is required to prevent infestation. Also, because the material does not lose effectiveness through absorption or dissipation, microorganisms have never been shown to develop immunity against it.

For the very first time, Dow Corning's new technology made it possible to actually control the growth and development of mildew and other microorganisms - including those with human health implications - on any treated surface, even after repeated cleanings and extended use.

This unique technology, now the ÆGIS Microbe Shield, has been widely used and is well reported on for its long-term effectiveness in the control of microbial contamination in indoor environments. Case histories and peer review publications show how this material, as part of a total program, provides relief and protection from indoor microbial problems.

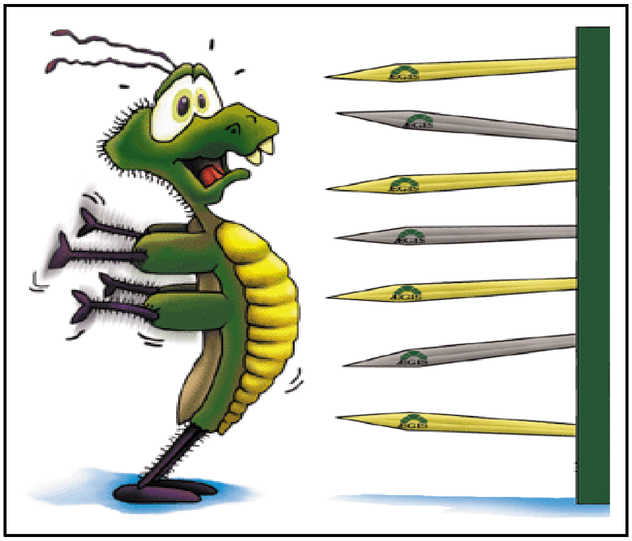
Defensive Strategies

Dealing with pollutant problems begins in the building design stage. Environmental elements, construction materials and techniques and building systems must be integrated to minimise microbial habitats and sources for particulates and volatile chemicals. Once commissioned and operating, proper maintenance of the air handling systems, other buildings systems and structural elements are critical. At this stage of a building's life, housekeeping and space design professionals must be in concert with facilities management so that, as staffing or work functions change, appropriate air and environmental control tactics can be implemented. The simplistic *solution to pollution is dilution* mentality is outdated.

A clear understanding of building use and practices plus careful selection of furnishings and operating equipment can greatly reduce pollutants in the indoor environment. There are also technological choices that make business and energy sense.

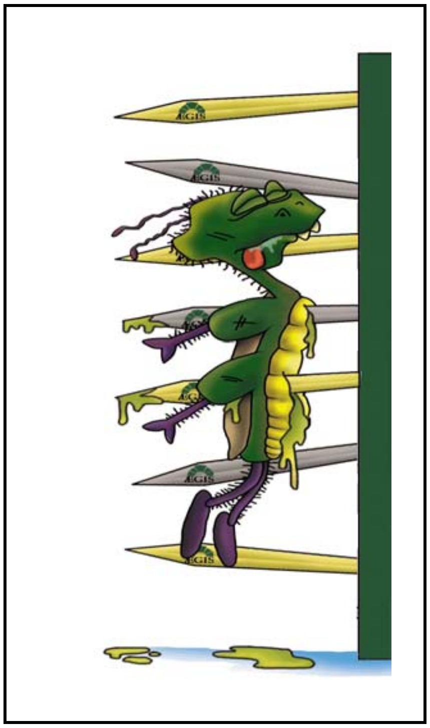
Microbiological control has moved from daily cleaners and disinfectants to non-volatilising, chemically bonded technology that durably modifies surfaces to prevent microbial growth. Proper targeting of surfaces will mitigate existing problems, greatly lower the odds of future contamination and stretch renovation schedules.

Chemistry and Mode of Action

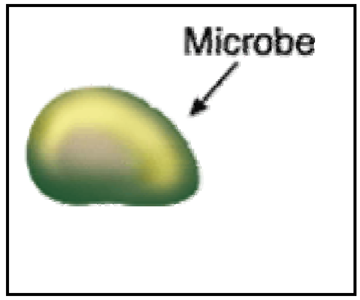


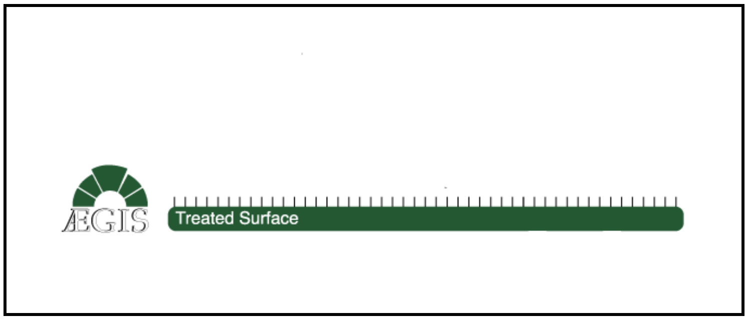
The ÆGIS Microbe Shield Program and its cornerstone chemistry AEM 5700 is registered in Canada with the Pest Management Regulatory Agency (PMRA) under the Pest Control Products Act, registration number 15133. Similar registrations with the United States Environmental Protection Agency (USEPA) and Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) are in force in the USA for similar usages. AEM 5700 is approved for use in Canada as a material preservative to be applied on-site to all indoor non-food contact porous and non-porous surfaces.

ÆGIS is a permanent antimicrobial that, when applied properly, becomes part of a new surface, a surface that is highly resistant to microbial attack. Unlike all other conventional antimicrobials, ÆGIS does not off gas, leach, diffuse, migrate, volatilise, or otherwise leave the surface to which it has been applied. The result is an extraordinary safety and efficacy profile unmatched by other products.

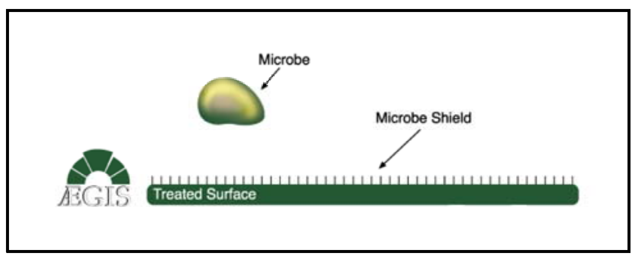


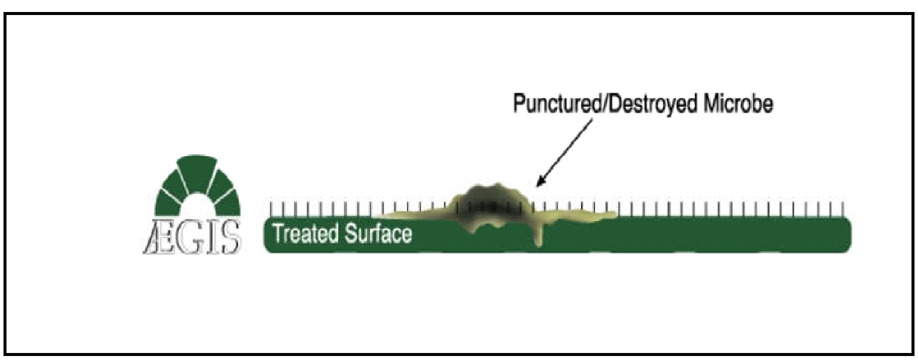
Antimicrobials can be divided into two major categories; bound and unbound. These terms refer to whether or not the antimicrobial has the capacity to molecularly bond to the surface on which it is applied. An *UNBOUND* must diffuse or leach from the treated surface and be consumed by the microorganism to be effective. Most conventional antimicrobials are intended to act quickly and dissipate quickly to minimise the danger to humans, animals and treated objects. Others use the time release capsule approach and obtain a longer working life by burying the antimicrobial in a paint, glue, binder or other coating and counting on slow migration to the surface. Conventional antimicrobials, even those applied in a carrier, must diffuse and create a “zone of inhibition” in order to function properly. Once inside the organism, the chemical agent will act like a poison, interrupting some key metabolic, or life sustaining process of the cell and causing it to die. Once the antimicrobial is depleted or washed away during regular maintenance, protection vanishes. After application, an unbound antimicrobial continues to diffuse or leach from the treated surface. As this diffusion continues, the concentration of the active ingredient eventually becomes diluted below effective levels. Under these conditions, microorganisms have the ability to adapt or build up a tolerance to these particular antimicrobials. Highly resistant strains can develop which are immune to what was once an effective dose.





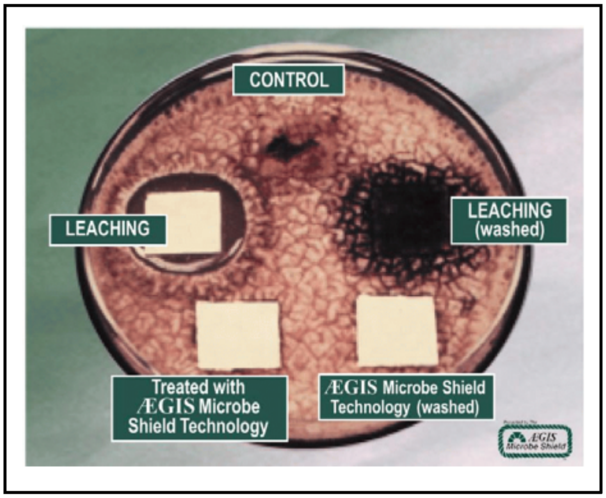
A *BOUND ANTIMICROBIAL* agent, like the ÆGIS Microbe Shield, remains chemically attached to the surface on which it is applied. It functions by interrupting the organism's delicate cell membrane. This prevents microorganisms from carrying on vital life processes. This antimicrobial acts on contact with organisms and can do so again and again. One can think of the bound antimicrobial like a sword that is capable of repeated use. In comparison, a conventional antimicrobial treatment is more like a gun with limited ammunition. Since a "bound" antimicrobial is fixed to the surface it continually operates at full strength. The natural genetic adaptation process, problematic with conventional antimicrobials, cannot and does not occur with the ÆGIS Microbe Shield.





The chemistry of the product is unique. A conventional quaternary ammonium salt is chemically spliced to a silane molecule, resulting in a highly active molecule (3-trimethoxysilylpropyldimethyloctadecyl ammonium chloride) that has both tenacious bonding capabilities as well as excellent antimicrobial properties. Once applied to a target surface it initially bonds to the surface on all available receptor sites (principally H^+). Afterward, stable bonds between remaining OH^- sites on the molecule and the positive charge on the nitrogen atoms (N^+) form, resulting in the creation of a large co-polymer involving the target and AEM 5700. Since there is no unused residue once the water evaporates, there is no dislodgeable residue and no odour, leaching, off-gassing, migration or diffusion of the molecule can occur.

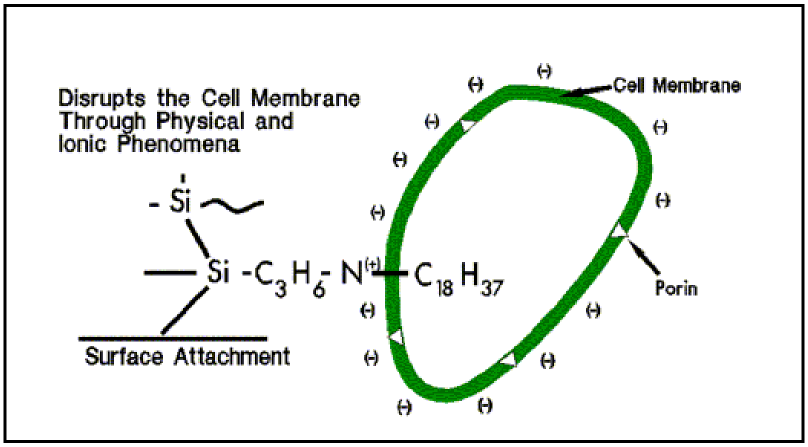
All other conventional antimicrobials work on the basis of diffusion away from the treated surface. This promotes adaptation, loss of activity, leaching, diffusion, and creation of zones of inhibition. AEM 5700 is essentially permanent, and these problems associated with conventional chemicals are not of concern.



Features

The ÆGIS Microbe Shield is a broad spectum antimicrobial that works effectively against the full array of microbes in buildings. Its features can be summarised as follows:

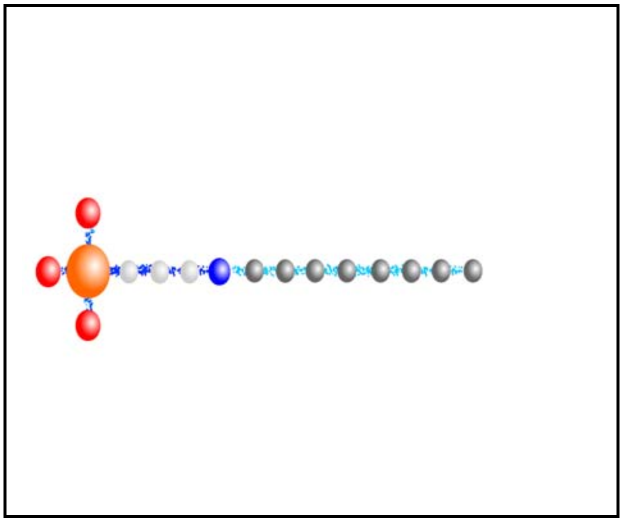
- odourless and colourless
- does not off gas
- does not promote genetic adaptation or encourage natural selection
- contains no heavy metals, phenols, arsenic, etc
- effective against all fungal and bacterial microbes found in buildings
- permanently bonds to target surfaces
- non-leaching and no zone of inhibition
- can be applied to almost all interior surfaces



Durability

The ÆGIS Microbe Shield works by forming ionic and covalent associations or bonds between itself and the target surface. These bonds are durable and firmly attach the molecule to the target surface and to each other, creating a co-polymer. This co-polymer has strong positive charges associated with the nitrogen atom that disrupt the cell membrane of the microbe, causing physical disruption similar to electrocution.

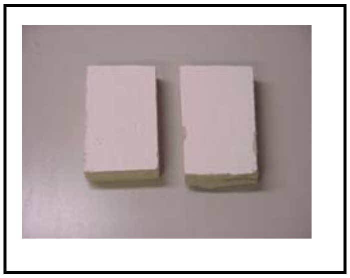
The long chain aliphatic component then acts like a sword, disrupting vital life processes. The organism is killed but the ÆGIS molecule does not leave the treated surface. It remains firmly bonded to the target surface, available to destroy the next microbe with which it comes in contact.

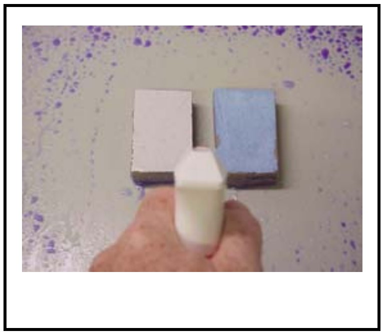


Because it does not kill the organisms by toxicity or poisoning, the organisms cannot adapt to it. Even with the natural variability in viability and resistance that exists in natural poulations, all of the microbes will be destroyed because the process is physical rather than chemical. The strength does not diminish with time or contact, eliminating the natural selection processes that all life forms undergo as they respond to changing environments.

The result is an antimicrobial that cannot diminish in strength, cannot leave the surface to which it is applied and cannot encourage the organisms that it targets to become used to it.

Verification





Consumers need to know that products used to control microbial growth can meet the performance claims that are offered.

The ÆGIS Microbe Shield can be detected on surfaces by staining the treated surfaces with a 0.04% solution of bromophenol blue. This organic dye bonds to the nitrogen in the molecules, permanently staining the treated surface a royal blue. Without the nitrogen present, the stain remains purple and is easily washed off the surface. The sidebar on the previous page shows the colour changes associated with various treatment levels.

Applications

The ÆGIS Microbe Shield can be applied in almost any environment where control of microbial growth or viability is needed.

After Disasters and Disaster Prevention:

- carpets
- drywall
- furnishings
- framing lumber
- new construction

Environmental Modification:

- shower stalls and bathroom components
- pool decks
- HVAC system components (insulation, coils, fans, walls, frames, etc)
- toilets and urinals
- gymnasiums and health clubs

Hypoallergenic Environments:

- bedding
- “touch” objects - doorknobs, railings, similar surfaces
- hospital surfaces

Remember, the first and best defense is a good offense. The importance of having a microbial pollutant control and prevention component as part of your contingency plan and having a baseline of knowledge about the microbial habitats in your building is critical. The usefulness of a proven, long-lasting, effective antimicrobial treatment that offers protection from the re-growth of microorganisms is essential.

visit us at www.Aegis-in-Canada.com

ÆGIS™

ÆGIS Environmental (Canada) Limited

116-900 Windmill Rd
Dartmouth, NS
B3B 1P7

902-468-5504

www.Aegis-in-Canada.com