Sick Buildings - Tracking Down the REAL Culprit

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W. Curtis White and Hal A. Locker, ÆGIS Environments

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Conventional wisdom says that, if a definite cause cannot be identified for a "sick building" problem, it must be the *fault* of the energy (HVAC) system. If you accept that premise, you have fallen into a logic trap.

Challenging the Logic Trap

It's time to challenge the assumptions which lead to this unsatisfactory conclusion. The Indoor Environmental Quality (IEQ) in a building and the energy system are inextricably bound, but, contrary to popular belief, the energy system is seldom the cause of IEQ problems. A poorly designed or maintained system definitely contributes by creating conditions which encourage the spread and severity of problems, but the source and blame for most IEQ problems lies elsewhere.

An energy system conceived as part of an integrated total environmental program provides building occupants not only with physical comfort but also with optimum conditions for productivity and health. Conversely, a system that ignores environmental effects and focuses solely on energy efficiency can cost millions of dollars in lost time, lost productivity, occupant healthcare and ultimately in renovation or remediation.

The Energy System Indictment

IEQ has become a major focus of legal, public and regulatory attention, and our modern, energy efficient buildings stand accused. Is the indictment valid or flawed? To answer that question we must reexamine how we manage and assess our indoor environments. Even more, we need to challenge the conventional wisdom which says that "toxic" chemicals are found at high levels, sick building problems must be caused by a "failure" of the air handling system.

Our technical ability to model and control the indoor environment and to test for potentially toxic chemicals has undergone a step change improvement in recent years, but we also have seen a dramatic increase in human health problems in our offices, schools, factories, and homes.

Why? Is the SBS phenomena simply an overblown exploitation of another new victim by the sensationalist media and greedy lawyers? If believing that makes you feel good, so be it, but there is a far better answer. The problem is real, but our analysis model is based on incorrect assumptions.

High Tech Problems - High Tech Solutions

We have assumed that SBS must be a high tech problem with a high tech cause. The chemical industry was the perfect villain. A few high visibility problems were directly tied to chemical exposure. Media inspired "chemophobia" and the industry's own scientific arrogance did the rest. In our politically correct indictment of "chemicals", we ignored the fact that our preferred cause correlated poorly with our problem.
There was and is a far better cause/problem correlation, but it is nowhere near as exciting or newsworthy. In fact, it is downright common and dull. Plain old mold and mildew provide a much stronger cause and effect relationship. Despite repeated alerts from microbiologists and medical researchers (too often buried in scientific journals and replete with esoteric explanations of such things as mycotoxins and aflatoxins), we all but ignored the potential danger of that fuzzy green and gray stuff that grows in the basement and smells bad. It's time to remedy that mistake.

The Fuzzy Gray Stuff

Microorganisms (or microbes) are part of our everyday lives and environments. 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 a 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. The few highly publicized 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.

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 which 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, the organisms are 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, rickettsia 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, sensitization, 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, it furnishings and its people offers a home for microorganisms. Microorganisms need moisture and nutrients and more that 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 resort 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.

Nutrients utilized 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 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 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 mold, 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 a 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, sensitizing 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 are 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.

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.

Traditional Solutions

Mold and mildew have been recognized for years as a major cause of problems in buildings; although most of the recognition had focused on odors, rot and unsightly growth rather than on human health problems. Management has struggled valiantly (but with minimal success) against mold 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.

Housekeeping procedures: Housekeeping professionals regularly scrutinize building spaces and remove any visible growth. Detergent/sanitizer products are effective short term tools against visible mold 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 odors develop, cleaning personnel frequently use perfumes and fragrances to mask or disguise the problem (and the often offensive odors of the sanitizers). These can create more of a problem than they solve for allergic and sensitive individuals.

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.

The air handling and engineering specialists have worked with filtration and extraction of pollutants but have generally concentrated on dilution. Recognizing 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. This moved the Standard to a range of 15 cfm/person to 20 cfm/person in general office spaces. The latter also assumes 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/benefits 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 that 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 (PEL's or TLV's) for the chemicals tested.

Although the presence of fungi or bacteria is commonly noted in reports, it seldom receives more than casual mention and 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 which range from beneficial to deadly, test methods which (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.

Additional procedures: As buildings age, the normal routines of clean-up and masking become less effective. Mold and mildew readily adapt to conventional sanitizers and biocides and many develop immunity. Also, we see clearly that certain species of fungi will find the engineered humidity and temperatures to their liking and will begin to thrive. Recognize that, as we adjust our indoor environments for the comfort of the occupants, we also create ideal habitats for a great variety of

microorganisms. When this happens, major corrective actions are required. These include exterior wall sealing with breathable water repellent coatings, replacement of furnishings such as carpeting and other soft goods, and upgrading components of the HVAC system.

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 on any treated surface - even after repeated cleanings and extended use.

This unique technology, now ÆGIS Antimicrobial, 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 IEQ 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 minimize microbial habitats and sources for particulates and VOC's. Once commissioned and operating, proper maintenance of the air handling system, other buildings systems and structural elements is 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 out dated.

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-volatilizing, 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.

The Future

With technologies in hand, we are at the threshold where energy management principals and benefits can be merged with the immense and immediate needs for improved IEQ. We can no longer ignore the critical relationship between energy management and the indoor environment. We need greater understanding and coordinated efforts within the professions and governmental agencies charged with addressing these vital issues.

About the Authors: Mr. White, a microbiologist and biochemist by training, is CEO and Technical Director of ÆGIS Environmental Management, Inc. in Midland, Michigan, a company specializing in providing solutions to microbially related IEQ problems. Mr. Locker is President and General Counsel of ÆGIS.