
"Warning on Indoor Air"
The West Australian - Oct 2002
"Office Building blamed for health problem"
The Advertiser - Nov. 1999
"Sick Building Syndrome leads to unwell staff"
Australian Financial Review - May 2004

A Breath of Fresh Air

Australians are now spending over 90% of their time in air conditioned environments, be it their home, workplace or the vehicles they drive. In fact most places that we visit have Heating Ventilation and Air Conditioning (HVAC) systems. As a consequence, the air quality within these environments and the health problems created by contaminated air pose significant health issues.

It is now well documented that poor indoor air quality leads directly to a number of health issues that range from minor skin and eye irritations to asthma, allergies, respiratory complaints and suppression of the immune system.

A World Health Organisation report in 1995 estimated that up to one third of buildings in industrialised countries are classified under the term "sick building syndrome". In Australia it is estimated that poor indoor air quality costs 12 billion dollars per year in lost productivity and illness.

We all enjoy the comforts provided by air conditioning systems, it is important that we recognize them as a source of potentially harmful microorganisms so need to be properly operated and maintained ensuring air delivery systems remain free of biological contamination thereby improving the health and quality of our indoor environments.

Right to Healthy Air

There has been significant focus on the hazards associated with outdoor pollution, however, insufficient emphasis has been placed on the potentially greater dangers associated with contaminated indoor environments.

We all have a right to healthy indoor air.

The World Health Organisation found in 1995 that "up to one third of buildings in industrialised countries are sick". Contaminated indoor air is a significant health issue, impacting on a large proportion of the community. The CSIRO reported (1998) that, "the airbourne biological and chemical cocktail Australians inhale in their homes and offices is costing approximately 12 billion dollars a year in sickness and lost productivity."

Governments and business groups spend vast amount of resources on Occupational Health and Safety programs. They now need to expand their focus and now investigate the wide range of potentially toxic substances within indoor environments.

Duty of Care

It is a fundamental duty of employers not to expose indoor inhabitants to hazards within the workplace.

Through a wide range of initiatives, Australian government, business and employee groups have collaborated to continually improve the safety and security of work place environments.

In the past, the focus of many of these programs has been on helping to minimise the occurrence of acute incidents. More recently, there has been a shift towards the recognition of workplace hazards where the symptoms manifest only over the long term.

Measures are now taken to limit exposure to heavy metals, asbestos from building materials, "passive" tobacco smoke and various environmental pollutants, all of which are considered contributors to chronic, long term health problems.

Directors and employers can no longer take comfort from the knowledge that measures have been taken to avoid acute incidents. Increasingly they must assume responsibility for any long term health consequences that staff might experience as a result of the particular environments in which they operate.

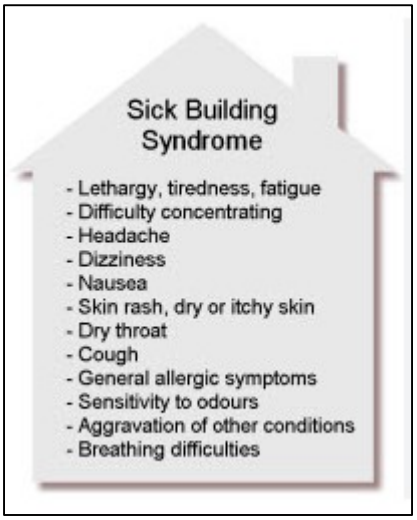
The chronic health effects of biologically contaminated air are now well documented.

All parties have a duty of care for anyone entering their premises that that all reasonable measures are taken to minimise the levels of harmful airborne contaminants in their buildings.

Sick Building Syndrome (SBS)

In 1983, the World Health Organisation defined the phenomenon of Sick Building Syndrome as "an excess of work-related irritations on the skin and mucous membranes and other symptoms including headache, fatigue and difficulty concentrating reported by workers in modern buildings."

Symptoms of high contaminant concentrations in indoor air include eye, nose and throat irritation and allergy, nausea and headaches. Some contaminants may also be potentially carcinogenic.



A Cocktail for Illness

Repeated exposure to organic materials of bacterial or fungal origin commonly found in indoor air can result in allergies such as asthma and rhinitis, extrinsic allergic alveolitis (a group of lung diseases), hyper sensitivity pneumonitis (which has flu-like symptoms), headache, fatigue and mucosal complaints, or organic dust toxic syndrome (recognised by tightness of the chest and bronchitis).

Exposure to these contaminants has also been shown to suppress the immune system, leading to increased susceptibility to infection.

As well as fungal and bacterial substances, air circulated by HVAC systems may also recycle a number of other microscopic particles. This organic dust carries various substances able to produce an inflammatory response. As a consequence, non-specific airways inflammation may play a crucial role in creating conditions for more serious illness.

Symptoms that may be experienced by the building occupants can include the following;

Symptoms

- **Headaches and Dizziness**
- **Nausea**
- **Aches and Pains**
- **Fatigue**
- **Poor Concentration**
- **Shortness of breath**
- **Chest Tightness**
- **Eye and Throat irritation**
- **Blocked or running nose**
- **Skin irritation**

It is likely that several of the systemic symptoms, such as headache, fatigue and joint pains which are associated with contaminated indoor air are caused by inflammatory mediators produced in the lung after inhalation and distributed to different parts of the body (Rylander 97).

Sources of the Problem

Air conditioning systems are the greatest contributor to energy consumption in a building. To maximise energy efficiency, indoor ventilation systems generally recycle the vast majority of the indoor air, introducing little outside "fresh" air. As a result, indoor concentrations of potentially toxic particles can increase over time.

Airbourne contaminants originate from a multitude of sources, ranging from the operation of office equipment to the fumes from solvents and resins, carpets and building materials.

However, it is well understood that a primary source of indoor air contamination is the bacterial and fungal colonisation of air filters, heat transfer coils and ductwork within the HVAC systems of buildings.

Filters

Air passes through filters prior to being cooled and introduced into the indoor environment. However, even high grade filters are ineffective at removing the smallest airbourne particulates, which pass unhindered into the indoor space.

Those dust particles trapped by the filter provide a source of nutrients, leading typically to rapid fungal colonisation. Commercial dust filters become highly contaminated and the fungal colonies produce spores, volatile organic compounds (VOC's) all of which contribute to elevated levels of harmful airbourne contaminants.

Specific micro-organisms (Mould/Fungi) commonly found within dust filters include:

- Aspergillus
- Penicillium
- Alternaria
- Cladosporium

Exposure to these organisms and to the mycotoxins that they produce can lead to immunological responses such as airway inflammation, hypersensitivity pneumonitis and asthma as well as respiratory tract infections and various allergic and toxic reactions.

Cooling Coils

The primary heat exchange components in an air handling system are the cooling coils. After passing through the filters, warm air is blown across the surface of the coils, where it is cooled, or "conditioned". This cooling process draws moisture out of the air, resulting typically in the precipitation of large volumes of water onto the coil surface.

The air passing across the coils carries with it a range of contaminants, including dust, micro-organisms and hydrocarbon fumes not removed by the filters. These particulates become entrapped on the wet coil surface. The entrapped micro-organisms have a natural predisposition to form biofilms, complex structures that enable extensive bacterial colonies to become entrenched. The damp cooling coils surfaces provide a plentiful supply of both nutrients and water, producing an ideal environment for micro-organisms to proliferate within these biofilms.

As the bacteria within the biofilms regenerate, they shed bacterial endotoxins and a range of

other potentially toxic organic fragments. These particulates, along with the microorganisms themselves, are introduced into the occupied space via the HVAC system.

Specific micro-organisms common within air conditioning cooling coils include:

- Bacillus
- Pseudomonas
- Flavobacterium
- Candida

Exposure to these organisms can lead to various immunological responses and allergic reactions. In cases where one's immune system has been compromised, exposure to these organisms can lead to pneumonia. This is of particular concern in hospital environments where poor indoor air quality is known to induce a range of nosocomial infections.

Ducts

The ductwork within air conditioned buildings presents by far the greatest surface area for potential microbial colonisation. However, it is the filters and the heat exchange coils within the air handling units that typically provide the source of bacteria and fungi. Provided these components are appropriately treated, significant microbial colonisation of the ductwork is unlikely.

Ducts should be inspected periodically to ensure that the surfaces remain clean. Where microbial growth is evident, immediate remediation is required. Internal duct surfaces may need to be treated to prevent the establishment of microbial growth.

Mould Contamination

Mould can grow on any surface within the building where moisture and nutrients are present.

Acoustic ceiling tiles and plasterboard are particularly susceptible when they become damp. This generally occurs when the drain line from a ceiling mounted air conditioning unit becomes blocked, leading to an overflow of condensate water onto the ceiling tiles and or plasterboard. This can be easily prevented by ensuring regular servicing of these units and through use of treatments to inhibit biofilm growth in the condensate trays.

Carpets and other indoor fabrics are also prone to mould growth when they become damp. It is essential that effected carpets are treated or replaced as soon as practicable. All sources of moisture into a building should be monitored.

Any water ingress that causes surfaces susceptible to mould growth to become damp should be rectified immediately.

Other Contributing Factors

Other building factors that can impact upon the indoor air quality are;

- Ergonomics
    - Temperature
    - Humidity
    - Lighting
    - Noise
- Chemical and Physical
    - Volatile Organic Carbons (VOC's)
    - Formaldehyde
    - Particulate matter
    - Dust
- Building Design and Construction Materials
    - Building Age
    - Building Materials
    - Furnishing materials
    - Cleaning Schedules

Prevention better than Cure

There are several potential reasons for compromised air quality in a building. However, bacterial or fungal colonisation of HVAC systems represents by far the most significant source of introduced biological contaminants.

It has become recognised that even a relatively minor amount of visible mould in a building requires remedial action. It is clear that microbial control is most effectively achieved by addressing the problem at its source.

Building managers should establish a program of regular scheduled maintenance and that Indoor Air Quality management becomes an integral component of standard maintenance programs.

While specific maintenance protocols vary between buildings, all should incorporate periodic cleaning and treatment of air handling surfaces along with regular objective assessment to confirm the efficacy of any biological treatment processes. Where visible mould is evident on any air handling surface, immediate remediation is required.

Air filters should be maintained according to the providers specifications and where appropriate

should be treated to inhibit fungal proliferation. Filters when left unchecked may become a source for fungal colonisation.

The approach to mechanical plant maintenance programs is that is should also focus on remediation and prevention. By implementing and adhering to a proactive monitoring, maintenance and treatment program, building managers can dramatically impact the levels of airborne biological contaminants within their indoor environments, contributing to improved health and well-being of all building occupants.

Other Benefits

Effective plant maintenance gives rise to a multitude of additional benefits beyond improved indoor air quality. Biofilm accelerates the corrosion and degradation of aluminum coil surfaces while fungal growth accelerates the rate at which filters become blocked.

By inhibiting microbial colonisation, one helps to extend the useful life of key air handling components. Well maintained mechanical plants consume far less energy than systems whose heat exchange and air resistance characteristics have been impaired by the presence of biofilm. Well maintained systems yield significant cost savings through improved operating efficiencies. With HVAC contributing materially to global energy use, this improved efficiency also yields direct environmental benefits and greenhouse gas reductions.

The case for effective IAQ maintenance procedures is compelling. Given its low implementation cost along with the human health, productivity, energy saving and environmental benefits, it should be an integral component of all effective building maintenance practices.

Implementation of an effective IAO maintenance program delivers multiple benefits:

- Healthier work environment
- Improved staff productivity
- Reduced staff absenteeism
- Reduced energy consumption
- Longer plant and equipment life
- Reduced greenhouse gas emissions

References

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- **Clean Air Society of Australia and New Zealand** www.casanz.org.au