



PASSIVE SOLUTIONS TO INDOOR AIR QUALITY



Sick Building Syndrome

The term 'sick building syndrome' was originally created when health care specialists correlated an increasing number of patients with headaches and allergies to the emission of volatile organic compounds (VOCs) within office environments and domestic dwellings. These toxic gases are emitted from many building products. They are partially responsible for an increase in respiratory and other serious health conditions. A number of VOCs are now recognised as carcinogens and are linked to an increase in cancer.¹

The following table highlights the average concentration of VOCs found within a typical building.²

It is estimated that people spend more than 90% of their lives indoors, therefore it is critical that the air quality of buildings is recognised as a matter of importance, especially when considering schools and health care facilities.³

Substance	Concentration (Ug/m3)	
Toulene	78,0	
Formaldehyde	58,3	Carcinogenic
Xylene	22,0	
Ethyl Benzene	10,0	Carcinogenic
a-Pinene	10,0	
Hexane	9,5	
Benzene	9,0	Carcinogenic
CycloHexene	8,0	
Butyl Acetate	6,2	
Styrene	2	Carcinogenic

Modern Building Design

As buildings have continued to evolve, a growing number of man-made materials are being used in modern construction. The impact of these materials on indoor air quality (IAQ) has been difficult to predict and has subsequently been compromised. From 2000-2010 energy prices rose by an estimated 28% and are set to rise in excess of 50% over the next two decades. Architects are now designing more energy efficient buildings to reduce costs and preserve heat. The most effective way to increase energy efficiency is to increase the thermal resistance of elements within the structure by applying insulation. Reduction of air leaks is also a key design element in new construction.

In many modern buildings, indoor air quality can be up to eight times worse than outdoor air due to lack of regular air circulation. This is particularly serious for buildings designed to accommodate the sick, elderly and children.

A lack of air circulation also means that volatile organic compounds, commonly found in buildings, could potentially rise to levels that are detrimental to the inhabitants' wellbeing.⁴

Without regular air flow, moisture levels are also likely to rise, creating a breeding ground for mould. This could then later develop into "toxic mould syndrome" which has previously been linked to sick building syndrome.⁵

Future Building Design

There is no doubt that as a growing number of VOCs are being classified as carcinogens, indoor air quality needs to be considered when specifying insulation.

Ventilation systems are effective but not an infallible method to address these issues. A combined approach is required to ensure occupants' wellbeing by maintaining a healthy indoor environment.

Specify Low Emission Materials

Minimising the use of building materials which have high emissions of VOCs is important at the design and specification stage. Materials that should be considered for a healthy indoor air quality are:

- Natural insulation materials: wool, hemp and wood fibre
- Zero to low VOC building boards and paints.
- Natural construction, stone, recycled materials.
- Timber without the use of toxic preservatives.

Natural products are increasingly being specified due to their technical superiority over many man-made products. Trends also indicate that a growing number of self-build project owners are seeking out natural product alternatives for a combination of environmental, technical and health benefits.

Highly Sensitive Buildings

When designing for especially sensitive buildings such as schools and health care facilities, consideration must be given to the vulnerability of the occupants who could already suffer from such illnesses as asthma and other serious conditions. Children are particularly susceptible to pollutants and combined with the amount of time spent indoors at school, it is essential that these learning environments do not put younger generations at risk of future health issues.⁶ With various contributing factors including damp, mould growth and VOCs, it is important for these buildings to maintain a healthy internal air quality.⁷

The number of children developing asthma has risen dramatically over the past decade and an attack can be triggered without warning.⁸ Medical experts recommend that regularly circulated clean air will help reduce 'triggers' by preventing the build up of noxious gases.



FORMALDEHYDE & TOLUENE

A Known Carcinogen

One commonly used toxic VOC is the chemical compound formaldehyde (CH₂O); a highly reactive agent that can cause violent immune system reactions in people upon initial and prolonged exposure.⁹ Health concerns relating to formaldehyde originally date back to the 1950s and include skin and eye irritation, respiratory problems, links to asthma, nausea, dry throats, headaches, dizziness and fatigue. Many of these symptoms disappear quickly as soon as the occupant leaves the affected area. There is also evidence suggesting that it is a contributing factor in diabetes and is a known cause of increased blood pressure in older women.¹⁰

Current Legislation on Formaldehyde

The United States Environmental Protection Agency (EPA) reported on July 7, 2010 that President Obama signed the Formaldehyde Standards for Composite Wood Products Act. This new legislation establishes set limits for the levels of formaldehyde emitted from composite wood products.¹¹

Many other health officials have now set limits and revised guidelines to levels as low as 0.04ppm, clearly indicating the growing global concern regarding the risks of formaldehyde. Permitted formaldehyde levels are currently being reviewed within Europe and it is expected that the standards will be tightened significantly. These changes would require architects to review which products could be specified in both commercial and domestic buildings.

Sources of Formaldehyde

Formaldehyde compounds are used in various building products including particle boards, OSB, MDF, plywood, some man-made insulations and various other building and household materials. Within a building structure, the total combined level of formaldehyde emitted from various building materials may exceed the recommended guidelines. Although man-made ventilation systems are commonly used for improving indoor air quality, they are not necessarily the most effective long term solution as they need routine servicing and often require regular filter changes. Not only is this a time-consuming task, it has to be assumed that long-term maintenance will be carried out.

Following the growing number of complaints attributed to poor IAQ, companies have been forced to take action by improving internal environments to ensure employee welfare. Health officials have created guidelines which state companies must achieve an “acceptable” level of IAQ to ensure employee wellbeing. In Hong Kong, the Environmental Protection Department have quantified the assessment of IAQ as “poor” to “excellent” by measuring nine parameters which include VOCs such as formaldehyde as a key source of indoor pollution.¹²

Long Term Formaldehyde Reduction

Trials undertaken in five houses to measure the effect wool had on formaldehyde levels proved that the dramatic initial reduction was maintained over an eighteen month period.

Formaldehyde Emissions Threaten Infant Schools

Several cases have been recorded of excessive formaldehyde levels present in schools; many of the children had a notable reaction on exposure to the chemical.

Specifically, an infant school in Langenfeld, Germany was temporarily closed due to excessive formaldehyde levels. Ventilation systems failed to resolve the issue and demolition was seriously considered until a passive solution was suggested.¹³

Over the past forty years, long term exposure to formaldehyde has been linked to impaired lung function, permanent and severe respiratory problems and is now officially recognised as a human carcinogen.¹⁴

Wool Locks Up 99% of Formaldehyde Permanently

Wool fibres are completely unique in their ability to permanently bond with 99% of formaldehyde present within twenty hours of direct exposure. Over a longer period of time the chemical chains are eventually broken down completely and rendered harmless.

Studies at Bangor University proved that formaldehyde is absorbed quickly and permanently locked up at a similar rate to that of moisture.¹⁵

Toluene; A Major Contributor to Indoor Pollution

Analysis conducted on internal air quality indicated that toluene is generally recorded to have the highest concentration in comparison to other VOCs. It is emitted from such products as adhesives, paints, coatings, particleboards, silicone sealants, varnishes, lacquers, primers, interior stains, clear finishes and wood furniture.

Whilst Toluene is not a known carcinogen, short-term exposure mainly affects the central nervous system, causing headaches, tiredness and confusion. The symptoms of short-term over-exposure usually clear up within a matter of hours, however, this exposure can compromise reaction times and increase the likelihood of accidents. Prolonged exposure can irritate the eyes and cause myriad skin conditions including rashes and dryness.

Wool Absorbs Toluene

Observations show a strong interaction between the lipid surface of the wool and the solvent. A school in Bielefeld, Germany was experiencing very high levels of toluene; during the renovation of the school, sheep's wool insulation was used to reduce the hazardous levels. The concentration of toluene was permanently reduced from the original 1100µg/m³ to 70µg/m³ which was measured to be significantly below the accepted level.

FORMALDEHYDE CASE STUDIES

Formaldehyde Affects Health of New Orleans Victims

Many occupants of temporary housing provided to victims of the New Orleans hurricane suffered serious health symptoms due to high levels of formaldehyde emitted from the construction products within the buildings.

The government requested designs from manufacturers to resolve such problems in the future. Sheep's wool insulation was proven to reduce formaldehyde to significantly below the permitted levels and is now approved as a future solution to similar problems.¹⁶

Wool Resolves Formaldehyde Issue at Infant School

The infant school in Langenfeld recorded initial formaldehyde levels of 0.2ppm which exceeded guidelines. After several attempts to ventilate the building, the city council were actively considering demolition but agreed to try installing sheep's wool insulation as a final measure to resolve the issue. Within three days the formaldehyde levels had dropped to 0.04ppm and the guideline of 0.1ppm had been successfully surpassed.¹⁷

Passive Absorbers

Sheep's wool insulation can be installed directly onto the source of the formaldehyde. Some panel and timber frame construction companies use sheep's wool insulation which will absorb and lock up formaldehyde emissions from OSBs and the frames.¹⁸

Formaldehyde has been a known concern for over sixty years and yet it is still a problem that we face today. Although regulations and guidelines are becoming increasingly restrictive, many households are still exposed to varying levels of formaldehyde and other VOCs.

In addition to excellent thermal performance and an ability to manage condensation levels, sheep's wool insulation is a unique long term passive solution for permanently locking up harmful VOCs and improving internal air quality.

It is essential to specify sheep's wool insulation that has a wool content which is greater than 90% to ensure optimum performance. Black Mountain sheep's wool insulation has a 95% wool content which is significantly higher than many competitor's products which often use plastic additives.

Other Factors Impacting on Indoor Air Quality

VOCs are emitted from within the built environment, however, there are other toxic gases that can impact the indoor air quality of a building. Nitrogen oxides (NO_x) and sulphur dioxide (SO₂) are both common pollutants emitted from combustion in the indoor environment. Sore throats and eye irritation are typical health effects at low levels of exposure.

Passive Solutions to Indoor Air Quality

Wool fibres have a unique ability to permanently absorb and break down volatile organic compounds (VOCs) and improve indoor air quality (IAQ). Wool fibres are natural proteins that are composed of a number of amino acids. These amino acids have reactive side chains which have a strong affinity for carbonyl groups contained within toxic VOCs such as formaldehyde, and similar groups in compounds like nitrogen oxides and sulphur dioxide.

Plants can also Improve Indoor Air Quality

Studies also indicate the positive change of IAQ in office environments with the introduction of plants. Improving IAQ in the workplace is not only an example of corporate social responsibility but it is also suggested that employee motivation and productivity will increase. There are a number of specific plants that act as 'natural air purifiers' and have been found to improve IAQ. Orchids are cited as being reactive with formaldehyde whereas Chinese Evergreens reduces Toluene levels.¹⁹

Indoor air quality can be up to eight times worse than outdoor

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