Simon Corbey, Associate Director and Gary Newman, Executive Chair of the ASBP discuss the role of products in delivering healthy buildings

ASBP The Alliance for Sustainable Building Products

HEALTHY BUILDINGS - THE ROLE OF PRODUCTS

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Introduction

Product selection is just one component of an extensive matrix which needs to be considered to ensure a healthy built environment. This matrix includes occupant behavior, acoustics, ventilation, day lighting and lighting, thermal comfort, external air quality, humidity and the passage of moisture.

Man-made chemicals have entered our bloodstream, as highlighted in WWF's Bad Blood, 2004 . They tested blood from 13 EU Environment Ministers and found an average of thirty-seven chemicals. Greenpeace (2015) identify 37,000 potentially hazardous chemicals.

Approximately 1,000 chemicals evaporate into the surrounding air and are breathed in. These are known as Volatile Organic Compounds (VOCs). We spend 90% of our time indoors, with indoor levels of VOCs often 2-5 times higher than outdoors and sometimes far greater (EFA, 2013). The industry needs to adopt the precautionary principle and exercise improved source control. Office workers may soon have an app on their phone, to measure indoor air quality (IAQ).

VOCs, Products and Health

VOCs are numerous, varied, and ubiquitous. They are contained within wood products - solid wood, engineered products (OSB, MDF), flooring products, coatings (paints, finishes, sealants, waxes), adhesives, mastics, cements, roofing materials, furniture, insulation and cleaning products. The cumulative effect of emissions from all the different sources should be taken into account, when considering IAQ.

It is widely acknowledged that the health effects of long-term exposure to low levels of VOCs are poorly researched. The health effects are usually referred to as:

Acute

- Irritation of eyes and respiratory tract
- General headaches, dizziness, lack of coordination, nausea and visual disorders
- Allergic reactions such as asthma and rhinitis.

Chronic

- Damage to liver, kidney, circulatory system and central nervous system, links to cancer.

We are all individuals, with different tolerances, so effects will vary. Not all VOCs are harmful and many are naturally occurring. The exhaled human breath contains a few hundred VOCs. Formaldehyde occurs naturally, is considered toxic in high quantities and is ever present.

The UK Building Regulations Part ADF, specify total VOCs or TVOCs emission should be below 300µg/m^3, over 8 hours. However, the European Protection Agency suggests these limits are without toxilogical justification (EFA, 2013). They report that children exposed to concentrations of VOCs higher than a median of 60µg/m^3, have a fourfold risk of asthma.

VOCs have long been associated as a trigger for asthma and there are 5.4 million people with asthma in the UK, with a NHS spend of £1 billion a year. According to Asthma UK (2016), on average there are three children with asthma in every UK classroom and we have amongst the highest prevalence rates of asthma symptoms in children worldwide.

This prevalence correlates with rising fuel poverty and cold, damp homes, with 28 percent of people contacted by the Energy Savings Trust, mentioning mould (EST, 2014). Housing Associations have reported a rise in complaints of damp, especially in retrofits (McCabe, 2015). WHO guidelines (2009)

state that dampness and mould related problems should be prevented and when they occur, they should be remedied. Several councils have been fined for letting damp properties. The Bonfield Review, set up in part to advise on this 3 years ago, is still awaited.

External air quality is examined in Every Breath We Take, Royal College of Physicians, 2016 . This study combined the PM2.5 and NO_2 figures to create a total figure of 9,500 annual deaths in London. The report acknowledges a lack of focus on IAQ and notes:

"The construction, occupancy, and exposure profiles of newer workplaces will lead to the potential for novel inhaled hazards and risks, and vigilance will be required in order to identify the occupational lung problems attributed to the workplace of tomorrow."

Measurement and Guidelines

VOCs are measured using thermal desorption gas chromatography mass spectrometry. Testing can be focussed on particular markers. For example, there are 22 VOCs that are mould growth indicators, suggesting the presence of damp.

Waverton Analytics (2016) analysed indoor air samples of approximately 8,000 homes through their IAQ Home Survey. The results are illustrated in Figure 1. The blue line represents the relationship between the percentage of homes and the TVOC levels. The mean value is 1,900 µg/m^3, while the mode is approximately 1,000 µg/m^3 . Waverton Analytics will use the same methodology and tools in a pilot project involving several London Councils that will commence in January 2017.

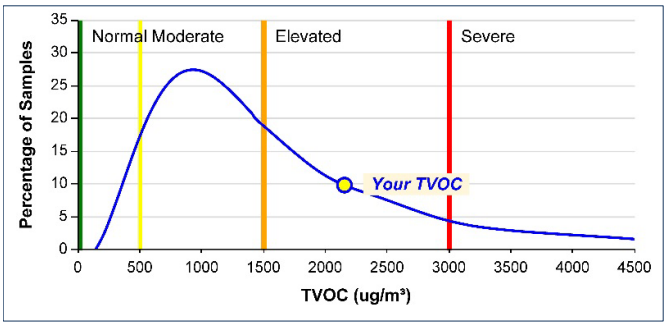

Figure 1: Data collected from >8,000 samples. Source: Waverton Analytics

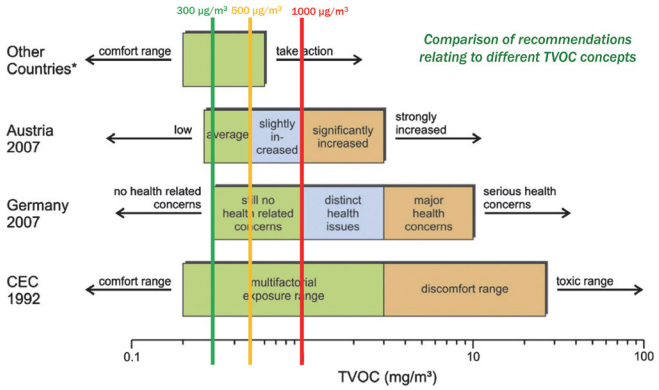

Figure 2: TVOC guidelines. Source: Waverton Analytics

NOTES:
1 Building Regulations Parts A, D, F (HM Government, 2010, 2011, 2013) and BREEAM Hea02 requires levels <300 µg/m3 post-construction, but preoccupancy (ie building-related TVOCs).
2 The WELL Building Standards requires 500 µg/m^3 as the upper limit.
3 The general consensus is symptoms begin to occur in certain people once TVOC levels exceed 1000 µg/m^3.

Regulatory background

CEN TC 351 has a remit for the development of horizontal standardised assessment methods for harmonised approaches relating to the release of regulated dangerous substances, under the Construction Products Directive (CPD). It addresses emission to indoor air, and release to soil, surface water and ground water.

The UK doesn't specifically regulate for source control. This is in direct contrast to France, which has established mandatory labelling Anses, covering VOC emissions classes for most construction products; walls, ceiling, floor coverings and coatings, insulation products, doors and windows, and more. Germany has similarly legislated, AgBB, as has Belgium. Germany is currently attempting to adopt standards beyond those of the Construction Products Regulations, perhaps an argument for Germexit. Voluntary schemes exist in Finland, Sweden and Denmark.

There are four UK government departments (in)directly responsible for IAQ., which may explain why we do not regulate for source control. DCLG is responsible for the Building Regulations. However, in practise ventilation is often far from adequate and does not comply with the regulations. DEFRA has the remit to deliver compliance with REACH regulations, the EU regulation on the use of chemical substances. *"The REACH process is driving standards and innovation"* state Chemsec , an NGO whose aim is a toxic free future. They have developed the SIN List , a searchable database of

830 substances, which will most likely be phased out under REACH. It should be noted that the REACH list contains just 194 substances of very high concern.

Chemsec suggest the way towards a toxic free world, within campaigning and legislative processes, should be based on four key principles:

- The Precautionary principle
- The Substitution principle
- The Polluter pays principle
- The Right to Know principle

The development of a draft EN test method to harmonise testing and labelling of construction products in the EU according to the emission of dangerous substances to indoor air, should be finalised in 2016. Performance classes for CE marking incorporating requirements for VOC emissions based on the harmonised test method are drafted, available on the BSI website .

Tools of interest

A key challenge for the construction industry is that we have neither the time, nor the skills, to grapple with complex chemistry and uncertain clinical evidence. In the absence of strong policy drivers, IAQ is an area where voluntary standards and procurement tools can assist. The ecolabel index indicates there are 120 ecolabels relating to construction products. Eurofins make some useful comparisons .

Regulation has driven significant reductions in toxins e.g. emission rates from wood based panels, as Europe tends to follow California. E1 panels currently have a formaldehyde level of 0.125 µg/m^3. Other, lower limits are also set in different countries, regions and by various organisations. For example, the voluntary German Blue Angel label would require levels of below 0.0625 µg/m^3, while the ecolabel Natureplus would be 0.045 µg/m^3.

Natureplus takes an evidenced based and holistic approach and considers product performance and sustainability, as well as impacts on human health in production and use. Exacting VOC emission limits are set down in a product standard and only products that meet this level can be certified. The natureplus product database is hosted in the procurement tool Baubook , which also provides procurement clauses, for tender documentation.

Building the evidence base

As mentioned previously, the health effects of long-term exposure to low levels of VOCs are poorly researched. Asthma UK concurs.

One study of real interest was on 400 children, who slept in bedrooms containing fumes from water-based paints and solvents, which are considered healthier substitutes to oil-based paints and solvents. It found they were two to four times more likely to suffer allergies or asthma because of exposure to propylene glycols and glycol ethers (PGEs) (Cone, 2010).

Most post occupation evaluation studies use CO_2 as a proxy for air quality, with the recommended guideline of 1,000 ppm. One excellent study, with a good summary of recent research, investigated Code for Sustainable Homes, level 3 and 4 homes in Ireland. In winter, carbon dioxide levels in the living room and main bedroom peaked above 1,000 ppm in all Code 3 and Code 4 dwellings, reaching levels as high as 3,427 ppm in the living room (9 pm–3 adults) and 4,456 ppm in the main bedroom. *"The high prevalence of Sick Building Syndrome symptoms in Code 3 dwellings suggests further investigation may be needed to identify the causes"* (McGill et al, 2015).

Whole House Standard for IAQ – Sentinel Haus

At an ASBP seminar, Volker Gutzeit of Sentinel Haus described a project, where two small children's classrooms were constructed in a laboratory. The first room used products the builder normally utilised and the second used Sentinel Haus approved products. TVOC was measured over the following eight weeks.

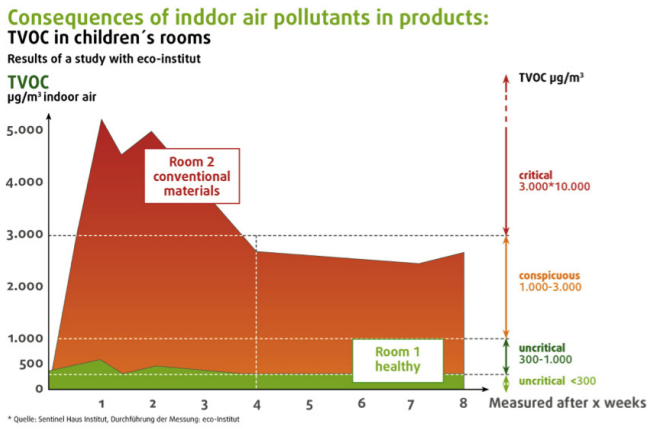

Figure 3: TVOCs measured over 8 weeks, comparing results from 2 rooms.

With the conventional materials, 5,000 µg/m^3 TVOC was measured in week 1 reducing to 2,800 µg/m^3 at 4 weeks, but then staying at that level, reducing to 2,700 µg/m^3 at 8 weeks. The German Environmental Protection Agency suggests anything over 1,000 µg/m^3 is not recommended as safe for long-term exposure. Results also demonstrated that when furniture was introduced, TVOC levels rose to 8,100 µg/m^3, a good argument for pre-off gassed furniture.

How does a designer specify low emission products?

The WELL Building Standard , developed by DELOS, insists that the VOC rating of all materials must be between negligible and zero. The first WELL Building in the UK, Cundall's One Carter Lane, achieved certification in July. As Cundall's Business Development Manager Jonnie Allen explained,
"...satisfying this proved to be one of the most challenging elements of the project, but we did it".

In order to achieve certification under WELL, the building must meet the required levels for formaldehyde and TVOC, and key product groups must meet VOC content/ emission requirements.

Clearly, as an industry, we have to up-skill ourselves, demand full disclosure of content of products from suppliers, confirmation that products do not contain any chemicals on the SIN list and encourage independently certified product testing. Enlightened clients are demanding this approach. BRE standards and Cambridge City Council's draft housing standard demand this approach. Organisations like the UK Centre for Moisture in Buildings, UKIEG and HEMAC will assist in growing the knowledge base.

Key product groups are paints and finishes, flooring, pressed wood products, glues, adhesives, furniture, insulation, copiers and cleaning products. We must ensure our tendering processes are robust enough to avoid product substitution. We must lobby for epidemiological studies and conduct more post occupancy studies. E.g: M&S - Meadowhall Centre, Architype – evaluation of 4 schools. VOC testing is inexpensive so could be introduced at various stages of the build.

Conclusion

The EEA (2013) eloquently conclude:
"The complexity of indoor pollution sources, health effects pathways and the multitude of parties responsible for generating and controlling indoor air pollution, suggest measures to improve IAQ, need to be part of a comprehensive management strategy, taking account of climate and outdoor air quality, building materials and technologies, behaviour patterns, as well as energy and sustainability policies".

ASBP believe that viewing the built environment through the prism of human health is an important focus for our industry. Products have a key role to play, but there is an urgent need for more evidence based studies, product testing and design tools to support good decision making.

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