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Timbercrete Campaspe Pty Ltd

Chemical Emissions and Heavy Metal Compliance Testing of Composite Brick Product

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1 EXECUTIVE SUMMARY

Cetec has evaluated both chemical emissions and heavy metal content of composite alternative brick material known as Timbercrete.

The emission rate of total volatile organic compounds from the product was well below the recognised limit of 0.5 $mg/m^2/hr$ at 24 hours. The heavy metal content of the Timbercrete product was negligible and does not pose a health issue to humans.

The composite alternative brick material can be classified as low-VOC emitting and having minimal toxicity from heavy metals.

2 INTRODUCTION

Timbercrete is a composite alternative clay brick material. Mr. Peter Collier invented the Timbercrete concept.

Presently there is intense activity in Australia regarding building sustainability or "green buildings". Organisations have formed to drive the adoption of "green building" practice; e.g. Green Building Council of Australia, or to recognise environmentally friendly products; e.g. Ecospecifier or Good Environmental Choice Australia.

Building products are coming under scrutiny for their environmental impact. A few parameter of interest are the emission of volatile organic chemicals from construction materials and their heavy metal content. Volatile organic compounds are organic compounds that may cause odours and irritation and are not conducive to a healthy indoor environment. On the other hand heavy metals can be source of toxicity to human health if they are in found in dust or debris.

Mr. Peter Collier commissioned Cetec Pty Ltd to undertake a chemical emission and heavy metal study of the Timbercrete product. The technique used to determine the chemical emissions comprised an environmental chamber. The product was monitored for environmental emissions of total organic volatile compounds for 24-hour period. Heavy metal content was also determined of the product.

Cetec Pty Ltd conducted the study in Melbourne during June and July 2007.

3 BACKGROUND

3.1 Indoor Air Quality

Indoor air quality (IAQ) is an important environmental consideration. People generally spend as much as 90 percent of their time in indoors and therefore, the quality of indoor air has a vital impact in human health. Today, buildings are designed to be airtight to save energy, resulting in less fresh air intake and a general build up of pollutants from building materials in the indoor environment.

In Australia the National Health and Medical Research Council (NHMRC) defines indoor air as the air within a building occupied for at least one hour by people of varying states of health. This includes any non-industrial indoor space i.e. office, classroom, transport facility, shopping centre, hospital and home. Indoor air quality can be defined as the totality of attributes of indoor air that affect a person's health and well being.

Increasingly, as buildings have become better sealed from the external environment, pollutants being released from indoor sources are being found at higher concentrations. Besides, the quality of air drawn from outside, the indoor environment is impacted by many factors. One group of indoor air pollutants is Volatile Organic Compounds (VOC). The number of complaints about indoor pollution caused by VOC has increased in recent times. Potential sources of indoor VOC include paints, decorative surface coatings, cleaning agents, finishes applied to textiles, solvents, adhesives, floor varnishes, furniture and carpets. These type of products all have the potential to impact the indoor air because they emit VOC into the air.

An outcome of the State of Washington East Campus Plus Program was that 96% of VOC found in a large office building following construction resulted from materials used to construct and furnish the building.

3.2 Volatile Organic Compounds

To avoid IAQ issues in workplaces and homes, interior furnishings should be low VOC emitters, with emissions (sometimes improperly called off-gassing), that dissipate quickly.

Volatile organic compounds (VOC) are organic compounds that often cause odours and irritation. Both the World Health Organisation (WHO) and Australia's NHMRC define VOC as organic compounds with boiling points between 50°C and 260°C, excluding pesticides. The term encompasses a very large and diverse group of carbon-containing compounds, including aliphatic, aromatic and halogenated hydrocarbons, aldehydes, ethers, esters, acids, alcohols and ketones.

The extent to which VOC can cause health problems depends on their toxicity, concentration and the duration of personal exposure. The health impacts resulting from exposure to individual chemical substances in building materials are not well understood. Many chemicals present in indoor air environments have not been evaluated thoroughly and little is known about their long-term health effects. Generally, the health effects of exposure to VOC in non-industrial indoor environments range from sensory irritation at low/medium levels of exposure to toxic effects at high exposure levels.

The measurement of total volatile organic compounds (TVOC) is frequently used to access indoor air quality because the interpretation of a single parameter is simpler and faster than the interpretation of the concentrations of several dozen VOC typically detected in doors. Non-specific TVOC measurements are a useful monitor for determining physical changes in a building’s indoor environment.

3.3 Heavy Metals

There are many metals that are of concern because of occupational or residential exposure and a major proportion of these are the heavy elements or "heavy metals". Small amounts of these elements are common in our environment and diet and are actually necessary for good health, but large amounts of any of them may cause acute or chronic toxicity (poisoning).

For some heavy metals, toxic levels can be just above the background concentrations naturally found in nature. Therefore, it is important to evaluate them and to take protective measures against excessive exposure.

3.4 Regulatory Limits

No regulations or codes have been developed specifically for indoor air in Australia except for some specific substances in the workplace environments. No single government authority in any jurisdiction has responsibility for indoor air quality in Australia. As such, there are no national regulations for VOC.

The NHMRC has developed Interim National Indoor Air quality goals for the maximum permissible levels of indoor pollutants. The indoor 'level of concern' for TVOC established by the NHMRC is that the total VOC concentration averaged over 1 hour is 500 ug/m^3, with no single VOC contributing 50% or more of this concentration.

In contrast to workplace and ambient air environments, there are no enforceable regulations specifically for nonworkplace indoor air environments. This situation is also common overseas. Regulating indoor air out of the workplace is difficult because any imposition of mandatory indoor air quality monitoring would be viewed by many people as unreasonably intrusive, particularly if private homes were to be included.

An alternative approach is to identify the sources of indoor air pollutants and other factors affecting indoor air quality and to make this information widely available. People can then make informed choices about matters affecting indoor air quality, at least in their homes. Individuals have limited ability to influence indoor air quality in public buildings such as schools, offices, hospitals and shopping malls, and a stronger case can be made for setting indoor air quality standards and/or guidelines for such buildings.

Throughout the world each individual country has developed their own compliance requirements for the emission rate of TVOC from a product. While this variety of test schedules may complicate the emission testing of a product there is fortunately some harmony between the many varied requirements.

Typically the products that are tested include carpet, textiles, furniture and fittings, paints, adhesives and sealants. The testing of brick type product for chemical emissions has not normally been conducted.

Governmental environmental protection organisations have regulations that apply for heavy metal content of soils and other materials and these can be used as guidelines in this case.

4 METHODOLOGY

Brick type products have not normally been considered as materials requiring chemical emissions testing. Nevertheless, the standard practice for the determination of volatile organic compounds in materials has been adopted. Heavy metal testing compliance criteria followed National Environmental Protection Council (NEPC) soil investigation levels.

4.1 Material

Timbercrete supplied brick product for testing (Table 1). The samples were obtained from recent production and collected according to a sampling protocol provided by Cetec. The samples provided may be considered representative of typical Timbercrete product.

Table 1: Sample Identification and Description

Sample Identification	Description
59920	Sawdust composite brick – use for VOC test
59921	Sawdust composite brick – use for heavy metal content test

4.2 Methods

The brick sample was tested in an environmental chamber constructed of highly polished metal. The chamber complied with the requirements of ASTM[1] with the experimental conditions of:

- Material loading in the environmental chambers was ca. 0.5 m^2/m^3;
- An air change rate of the environmental chambers of 1 per hour;
- Controlled temperature of $23^0C\pm2^oC$ and 50%±5% relative humidity.

1 ASTM D5116-97, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Material/Products.

Chemical emissions from the sample were collected over the 24 hours following placing the sample in the environmental chamber. The TVOC emitted from the test materials were determined using diffusive sampling methods. The methodology was based on ISO 16200[2]. At the nominated sampling periods a sorbent tube was attached to the air outlet from each environmental chamber to collect the chemical emissions.

The TVOC was determined using gas chromatography (GC) equipped with flame ionisation spectroscopy (FID) and quantitated by reference to toluene.

4.3 Method – Heavy Metal Content

The experimental approach followed USEPA 6020 Heavy Metals and USEPA 7470/71 Mercury methodology.

2 ISO 16200-2:2000, Workplace air quality – sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography, Part 2: Diffusive sampling methods.

5 RESULTS

5.1 Concentration & Emission Levels

The concentrations of TVOC emitted from composite brick material under study together with the calculated emission rates are shown in Table 2.

Table 2: TVOC Emission Data

Laboratory Identification	Product	24-Hours	
		Concentration (mg/sample)	Specific Area Emission rate (mg/m^2/hr)
Blank		0.001	Not Applicable
59920	Timbercrete Brick	0.014	<0.1

Typically materials should have an emission rate less than 0.5 mg/m^2/hr at 24 hours. The Timbercrete product was well below this. Examination of the gas chromatogram profile of the emissions from the product identified the TVOC as chemical compounds that at the very low emissions detected would not pose a health issue to humans. Certainly no recognised chemicals of concern; e.g. carcinogens, mutagens or teratogens, were detected in the chemical emissions.

5.2 Environmental Chambers

While larger buildings are more likely to have mechanical ventilation systems that can filter out some pollutants, buildings are designed to be air-tight to save energy, resulting in less fresh air intake and a general build up of pollutants from building materials in the indoor environment. For this study, small environmental chambers adopting passive adsorption techniques were used better mirror the real indoor environment compared to an active system; in addition diffusive emissions are not affected by airflow.

The TVOC emission rates and concentrations in the chamber measured in this study are likely to be higher than concentrations in a real environment because:

1. The chamber concentrations were for fresh material and measured in a static environment. Even with limited natural ventilation in a building and assuming a declining emission with age; the chamber method should result in higher concentration than in a non-industrial environment.
2. Concentrations depend on the amount of floor surfaces in the premises and the air exchange rate. In most cases, the area-to-volume ratio in the chamber will differ from the ratio in a commercial office. The lesser the loading ratio, the lower the total concentration of the materials in the environment.
3. Indoor air quality is affected by a number of factors including the ability of other surfaces to adsorb VOC. Some furnishing within a room may act as sink for VOC of low volatility, which may then be re-emitted over extended times at lower rates, resulting in lower emissions.

5.3 Heavy Metal Content

Table 3 provides the detail of heavy metal content of the composite brick material.

In many cases the heavy metal content was below the detection limit. Otherwise the heavy metal content was well below the limits established by the NEPC as guidelines for investigation levels for soil. The level of heavy metal content was below recognised toxicity levels.

Table 3: Heavy Metal Content

Metal	59921 mg/kg
Antimony	<10
Arsenic	5.6
Beryllium	<2
Cadmium	<0.5
Chromium	6.5
Cobalt	<5
Copper	<5
Lead	<5
Mercury	<0.1
Molybdenum	<10
Nickel	<5
Selenium	<2
Tin	<10
Zinc	17

6 CONCLUSION

Environmental testing of composite alternative brick material known as Timbercrete has been completed. Both chemical emissions and heavy metal content were evaluated.

The emission rate of total volatile organic compounds from the product was well below the recognised limit of 0.5 $mg/m^2/hr$ at 24 hours. The Timbercrete product can be classified as low-VOC emitting. The chemical compounds detected in the low VOC emissions from the products were not recognised chemicals of concern and would not pose a health issue to humans.

The heavy metal content of the Timbercrete product was negligible and can be classified as having a very low heavy metal content. The heavy metal content does not pose a health issue to humans.

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