My home is making me sick! Implications of poor indoor environment quality on mould growth

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Abstract

It is estimated that 1 in 3 Australian homes displays excessive dampness and mould proliferation, representing a significant threat to human health (physical and psychological). This study aims to provide a snapshot of the current indoor air quality of Australian residential buildings regarding air pollutants and biological growth via a case study. Monitoring results indicate that buildings with a high concentration of fungal spores are also more likely to present poor indoor air quality levels, high concentrations of particulate matters (PM_{10} and $PM_{2.5}$) and CO_2. Further, it suggests that the extensive mould damage may go inviable for too long posing a significant health hazard on people. This research suggests the need for the development of early detection strategies that could minimize the health hazard to people, thereby preventing the need for a major renovation.

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Keywords: mould growth; hygrothermal; indoor environment; health

Nomenclature

IAQ	Indoor air quality
PM_{xx}	Particulate matter (XX maximum diameter)
CO_2	Carbon dioxide

1. Background

It has been estimated that one in every three Australian homes displays excessive dampness and/or mould proliferation [1, 2], which are known to be exacerbated by inadequate architectural strategies, poor construction practices and maintenance, and a consequence of a lack of awareness and knowledge in the sector about the topic [3]. Indoor mould is correlated with severe adverse health symptoms [4, 5], and it is responsible for early biodeterioration of building materials [6] which in turn often prompts costly renovation works. Mould can be caused by the presence of excessive moisture or water within a building component, extreme events (such as flooding) or condensation issues, with the latter being caused by lack of attention to the problem during the design stage. The issue is further amplified by the difficulty of detecting mould before it is fully germinated [3]. This study aims to explore the correlations between air pollutants, indoor air quality and biological growth in the Australian context. The ultimate goal is to develop a better understanding of possible indicators of mould presence that can be diffusely used for early detection, which, in turn, may prevent serious health implications and significant economic loss. This paper presents an investigation conducted on a residential building in Gowrie, ACT in Australia. The analysis has been prompted by adverse health symptoms observed in the one building occupant, which were not followed by clinical reasons.

2. Method

The case study is a two-storey residential building located in Gowrie, a suburb of Canberra ACT, Australia, characterized by oceanic climate [7]. Built before 1988, at the time of the investigation the building did not undertake a major renovation. The architecture of the building comprises a split level with high raked ceilings and a mezzanine level, four bedrooms and two bathrooms. The bedrooms, bathrooms, laundry and kitchen face South (southern hemisphere), while the lounge and entry face the North. The investigation included a site inspection, air testing and surface swabs for mould detection, as well as a monitoring indoor air quality (IAQ) campaign two-month long (during winter). Table 1 indicates the sensors installed on the property.

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Table 1. IAQ monitoring campaign: sensor installed in the property

Parameter monitored	Sensor type	Accuracy	Resolution	Range
PM_{10}; $PM_{2.5}$	Light scattering (350nm)	±10% (<30µg/m³ ±3µg/m³)	1µg/m³	1 / 100030µg/m³
CO_2	Non-dispersive infrared	±3% ±50ppm	1ppm	400 / 2000ppm
TVOC	MOS	±15%	1ppb	N/A
Temperature	Digital	±1°C	1°C	-200 / 100°C
Relative Humidity	Digital	±5%	1%	0 / 99%

3. Results

Observations: The initial inspection of the premise revealed that the lower level of the split-level home had poor natural light and several unused bedrooms closed from the hallway with curtains drawn inside. This contributed to achieving little to no natural ventilation throughout the lower level of the home where all bedrooms, bathrooms and laundry are located. Further, a leaky wall cavity from the shower was wet, damaging the surrounding bedrooms. Further, surface swabs taken revealed toxic levels of *Aspergillus* and *Penicillium* in the kitchen, hallway and main bedroom. The observed water-induced damages, coupled with the absence of solar radiation penetration and natural ventilation of the spaces, contributed to the high diffusion of the spores.

Monitoring Results: The air samples indicated the biological contaminants included at least 24 different fungal strains, of which: i) 50% are usually regarded as a source of raspatory infections, ii) 21% able to produce mycotoxins, which constitutes a second health hazard, and iii) 25% usually considered a proxy for condensation issues. Further, the monitoring campaign revealed that more than 80% of the time the temperature was below 18°C, and 42% below 14°C, while 81% of the time the RH was in the optimal range of 0.4 to 0.7. Graph 1 indicates that the pollutants concentrations have been consistently higher than the expected thresholds [8, 9]. This might suggest that space was significantly under-ventilated and that these parameters may be considered good indicators for early detection of high moisture-related risk probability.

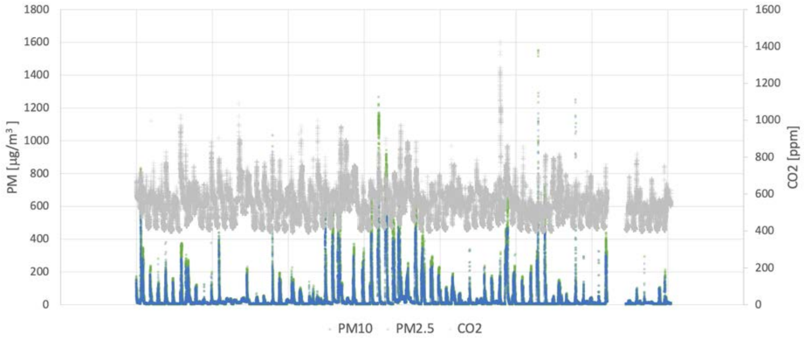

Fig. 1: Results for pollutants monitoring. The acceptable thresholds are fixed at: PM10<50µg/m3/hour, PM2.5 <25µg/m3/hour [10], and CO2<850ppm [9]

4. Conclusions

The investigation shows that the extensive mould infestations may easily go undetected for far too long, which in turn requires significant renovations to completely remove this significant health hazard from damaged premises. Further, buildings with a high concentration of fungal spores are also more likely to present poor IAQ, high concentrations of particulate matter (PM_{10} and $PM_{2.5}$), as well as a high level of CO_2. This case study underlines the necessity of developing early detection strategies that could minimize the risk for occupants, as well as reducing the cost of repairs. Further, it calls for a change in the construction practice to address this issue at the design stage by establishing a prevention-based approach, rather than remediation.

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