Indoor VOC composition and PM in Lancashire homes

Dr. Hannah M. Newton, Dr. Andrew Sweetman and Prof. C.N. Hewitt

Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ

Correspondence to: h.newton@lancaster.ac.uk Tel:+44(0)1524 593993

Introduction

Europeans spend on average 91% of their time indoors. Since buildings became better sealed in the 1970s, with the roll-out of double glazing, the impact of poor indoor air quality (IAQ) on occupants has increased (WMO 2006).

Volatile organic compounds (VOCs) can contribute to poor IAQ, as can particulate matter (PM). Both VOCs and PM have been linked to symptoms of *Sick Building Syndrome*: an ambiguous term describing a wide range of symptoms related to a particular building (Redlich et al., 1997). VOCs can be irritants or even carcinogens, whilst PM can penetrate deep into the respiratory system: the finer the PM fraction, the deeper into the breathing passages and lungs that they can penetrate.

In this work VOC composition of indoor air and the PM concentrations are studied to assess variability within the home and aid a comparison between buildings of different ages.

Methods

Samples obtained using Radielllo® passive sampling equipment shown in Fig 1. Radiello® tenax cartridges were used with a yellow diffusive membrane to control the diffusion rate and sample load onto the cartridge. These were then mounted on Radiello® vertical adapters and placed in the home (Figure 1(b)).

The rooms sampled were the lounge, kitchen and main bedroom. These rooms were selected on the basis of average time spent in a room. Three replicates per room.

Figure 1: Radiello® passive sampling equipment. (a) cartridge lapel sampler and thermal desorption tubes and (b) mounted on vertical adapter for home sampling.

The Radiello® cartridges were then inserted in thermal desorption tubes for analysis by an auto thermal desorption gas chromatography mass spectrometry (ATD-GC-MS) system.

Table 1: Summary of site characteristics.

	House #1	House #2
Property age	Early 1800s	1990s
Number of occupants	2	4
Gas cooking	Yes	Yes
Open fire	No	Yes (gas)
Wood burner	Yes	No
Carpeted	No	Yes
Pets	Yes (1 cat)	Yes (2 dogs)
House plants	Yes (~2 per room)	No
Smokers	No	No
Air fresheners	No	No

VOC measurements

The replicates within each room exhibit good reproducibility, suggesting that the room atmospheres are well mixed and the sampling locations are appropriate.

The concentrations of limonene and alpha-pinene appear higher in House#1, likely due to the presence of house plants.

The kitchen samples are showing the highest concentrations and range of VOCs in the indoor air.

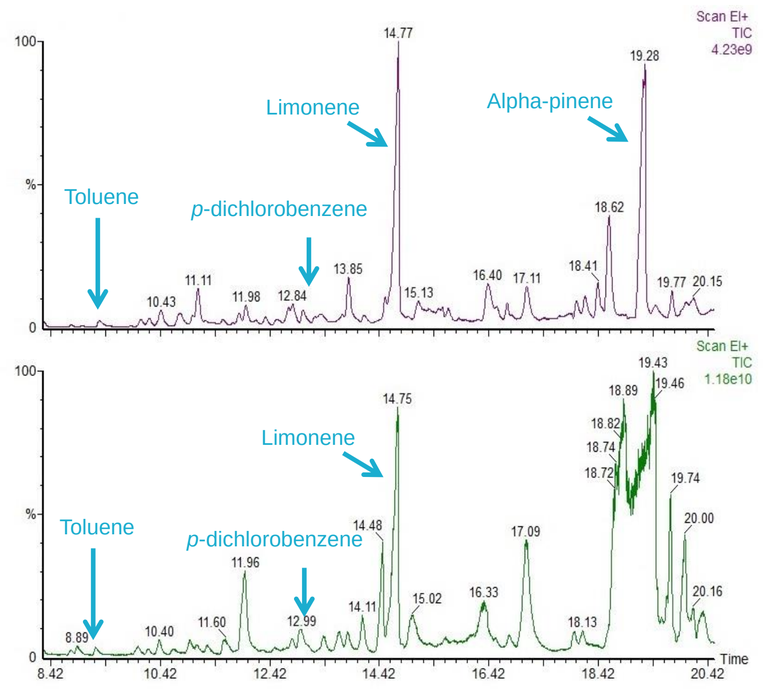

Figure 2: Snapshot of chromatograms from ATD-GCMS analysis of the kitchen indoor air in (a) House#1 and (b) House#2. The peaks are shown as relative percentages.

PM measurements: House #1

PM data shows far higher mass per unit volume with the wood burner lit in the lounge , but the small fractions still dominate the PM composition in the room (Figure 3).

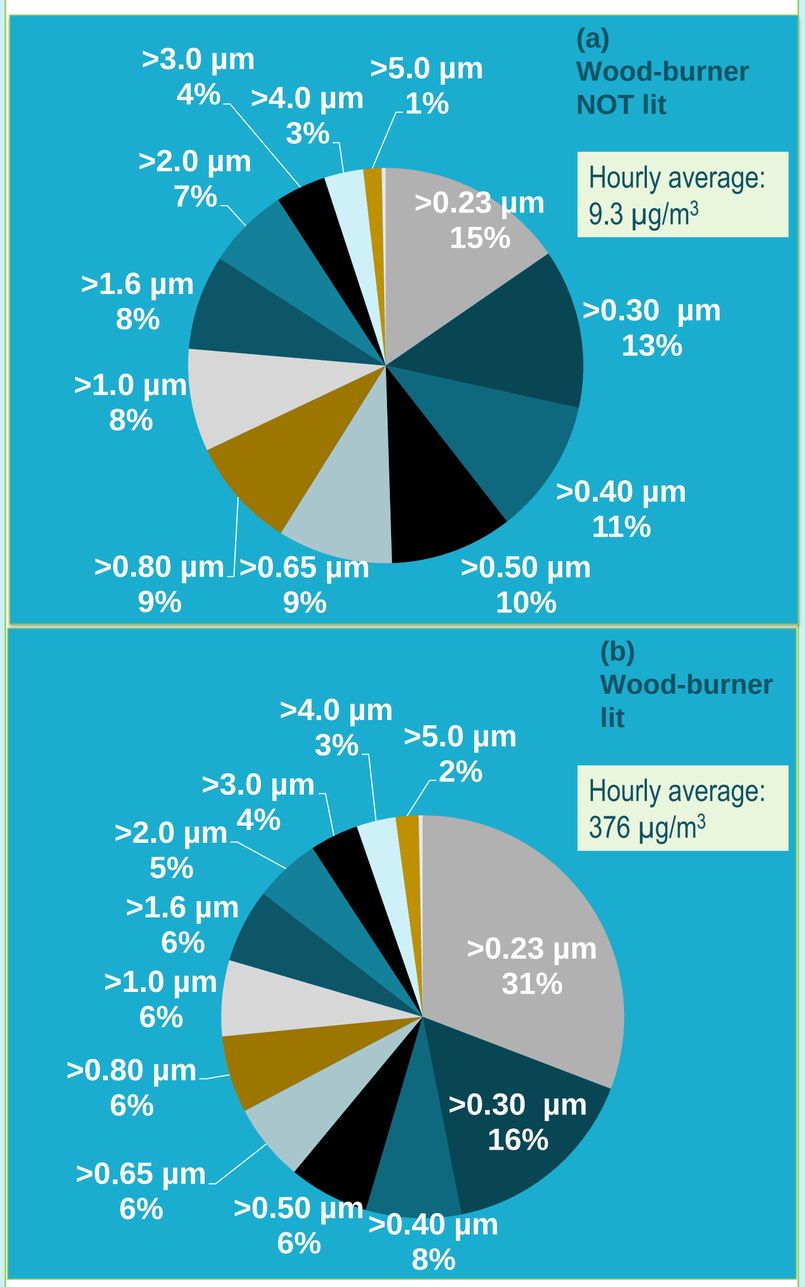

Figure 3: PM fractions in the lounge atmosphere without the wood-burner alight (a) and with it alight (b).

INTASENSE

Integrated Air Quality Sensor for Energy Efficient Environment Control
www.intasense.eu

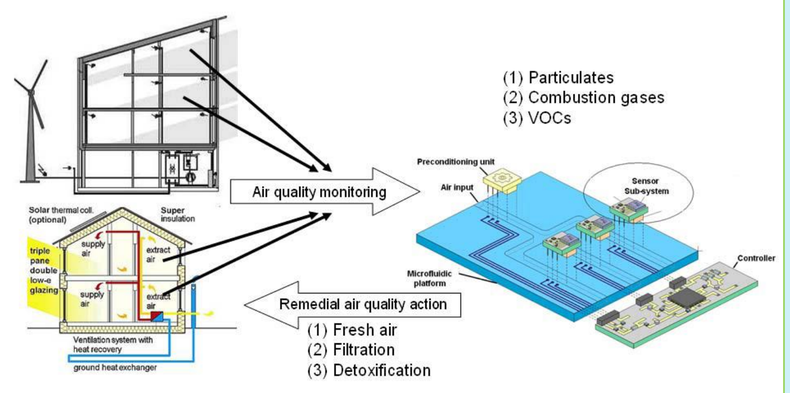

Figure 4: INTASENSE concept

This is a FP7 project to produce a miniaturise IAQ measurement system.

Lancaster are leading the design, specification and regulation package for the project. A review was made of indoor pollutants deemed high priory and appropriate for long term monitoring in HVAC controlled buildings. From that review the INTASENSE target compounds were agreed:

- CO, CO_2, NO_2, O_3
- Benzene, toluene, *p*-dichlorobenzene, formaldehyde
- PM_{10}, $PM_{2.5}$

European project partners are currently developing the sensor. Prototypes will be validated at Lancaster Environment Centre using the ATD-GC-MS to assess the selectivity of the sensor to the target VOCs. The GRIMM particle counter will be used as part of the PM validation of the sensor.

Summary and further work

- Using passive air samplers to compare the IAQ between homes
- To-date, two separate monthly sampling periods have been undertaken in each house (December and February).
- Preliminary data show the kitchens to have the highest abundance of chemical species
- Good agreement of replicates within each room
- Occupants have filled in a questionnaire on characteristics of the property
- PM data show high absolute mass per unit volumes with a wood burning stove alight.

- Sampling with the Radello® system will be repeated a third time in April and again in the summer to look for seasonal differences.
- PM measurements will be made in House#2.
- IAQ sampling will be undertaken in HVAC controlled buildings at Lancaster University
- Validation of INTASENSE prototype to begin Sept 2013

References

Redlich, C. A., J. Sparer and M. R. Cullen (1997). "Sick-building syndrome." The Lancet **349**(9057): 1013-1016.

WHO (2006). Air quality guidelines. Global update 2005. . The WHO European Centre for Environment and Health, Bonn Office, World Health Organization: 484.