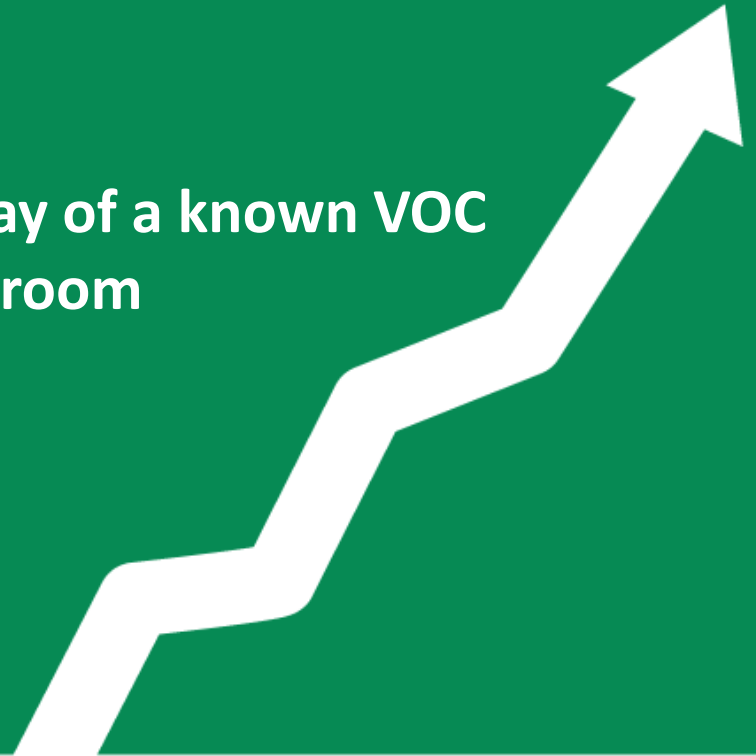


How soon to reoccupy?

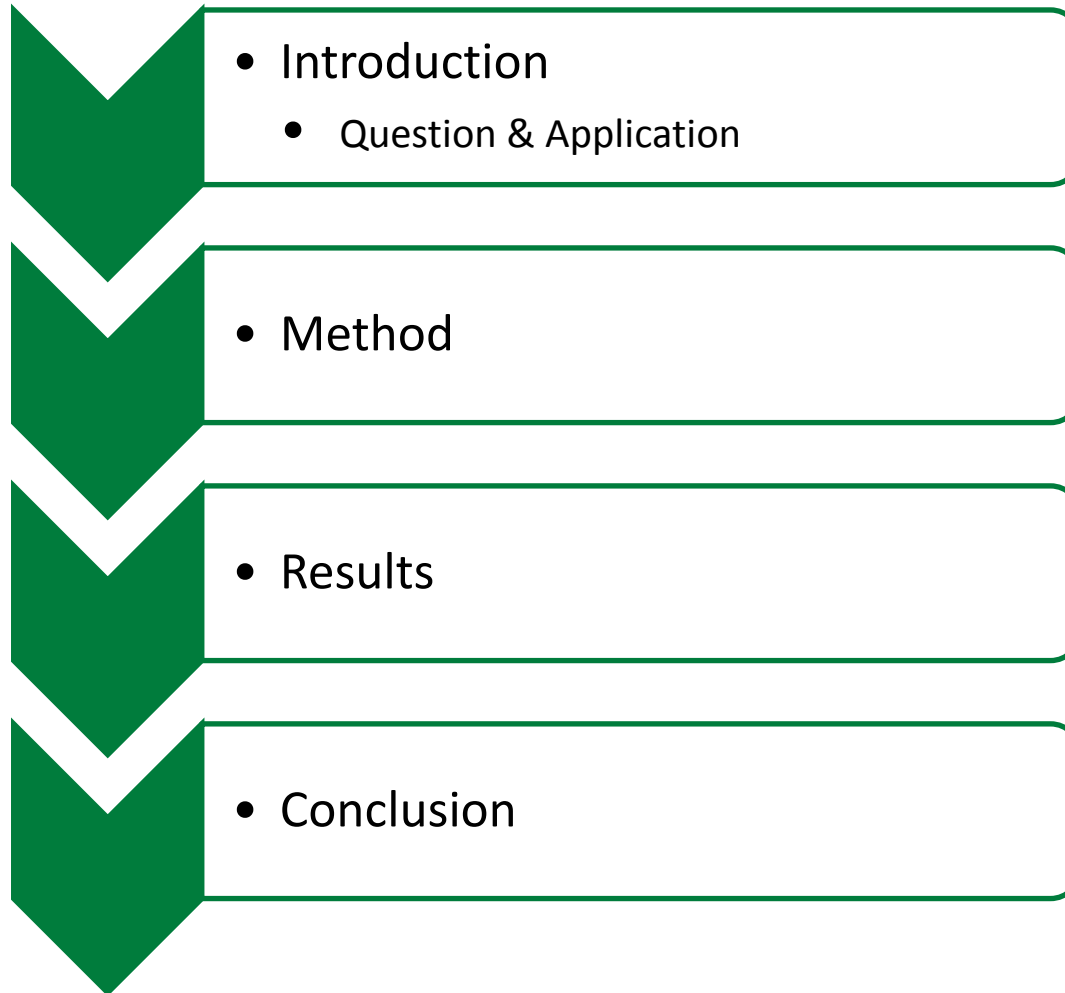
-Plotting decay rates following a spray of a known VOC concentration mixture into a sealed room

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Agenda





A Joint Study

- CETEC Pty Ltd and
- Fraunhofer Institute for Building Physics (IBP)

Conducted at the IBP test centre in Holzkirchen Germany

Fraunhofer IBP, Germany
Christian Scherer, Florian Mayer

CETEC, Australia
Adam Garnys, Vyt Garnys





Fact:

Introduction of new fitout materials = Increased VOC and formaldehyde levels
e.g. furniture, paint, construction adhesives, carpet, insulation.

Question:

What is the optimal timeframe for re-occupation following introduction of VOCs?
What are the rates of VOC decay / re-absorption?

Application:

Accurate projection of VOC levels following construction – for reoccupation
Occupant adverse health events – reverse modelling

Benefits to architects, project managers, facility managers and property owners.
Ability to accurately determine when VOC levels have reduced to safe levels following construction.



Test room:

7.9m x 3.97m .

Room air 100% re-circulated.

Supply air by two swirl diffusers and
return via one intake vent.

VOC Spray

A known cocktail and amount of
common representative VOCs was
sprayed in the return air vent at
time zero = $5000\mu\text{g}/\text{m}^3$






Measurements:

- VOC every hour for 7 hours
- VOC at 24 hours after spray

- 4 Sample locations
 - NW, NE, SW, SE

- 3 different heights - to investigate VOC stratification;
 - low near the floor ($\approx 0.3\text{m}$),
 - medium to replicate seated breathing level ($\approx 0.84\text{m}$)
 - high to replicate standing breathing height ($\approx 1.68\text{m}$).



- 
- VOC analytical methods
 - VOC by GCMS of coconut shell carbon (CSC)
 - Formaldehyde by XAD-2 tubes,
 - VOC by Thermal extraction of TENAX TA
 - Instantaneous VOC data-logging by PID and process-FID.

 - Other Measures :

Temperature, relative humidity and data from the room's dedicated heating, ventilation and air-conditioning (HVAC) system

- Fit-out materials for VOC absorption
 - New ceiling and carpet tiles placed in the test room
 - To determine absorption of the VOCs
 - Tested as per the small chamber ASTM D5116 laboratory method for 24 hours at 22°C then for 4 hours at 40°C.



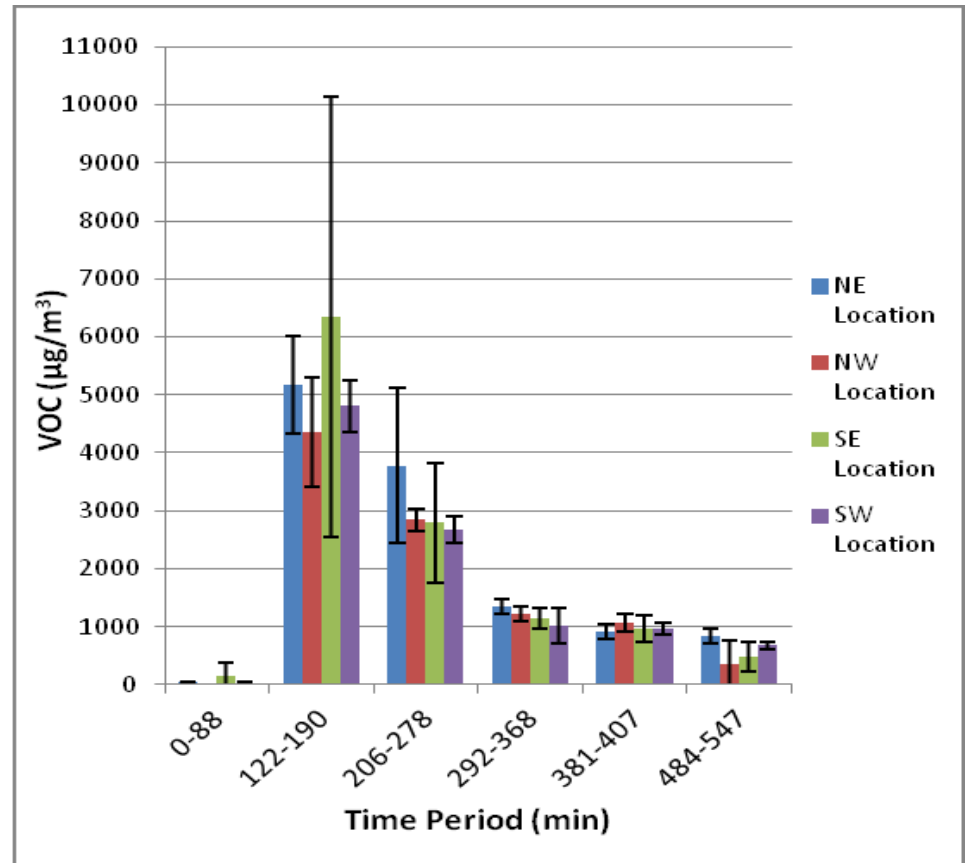


Free VOC Decay

VOCs reduced to approximately 10% of their original value after 9 hours ($\approx 5000\mu\text{g}/\text{m}^3$ down to $500\mu\text{g}/\text{m}^3$).

At 24 hours VOCs were recorded as low as $306\mu\text{g}/\text{m}^3$

Formaldehyde remained reasonably stable with ~30% reduction in air concentration

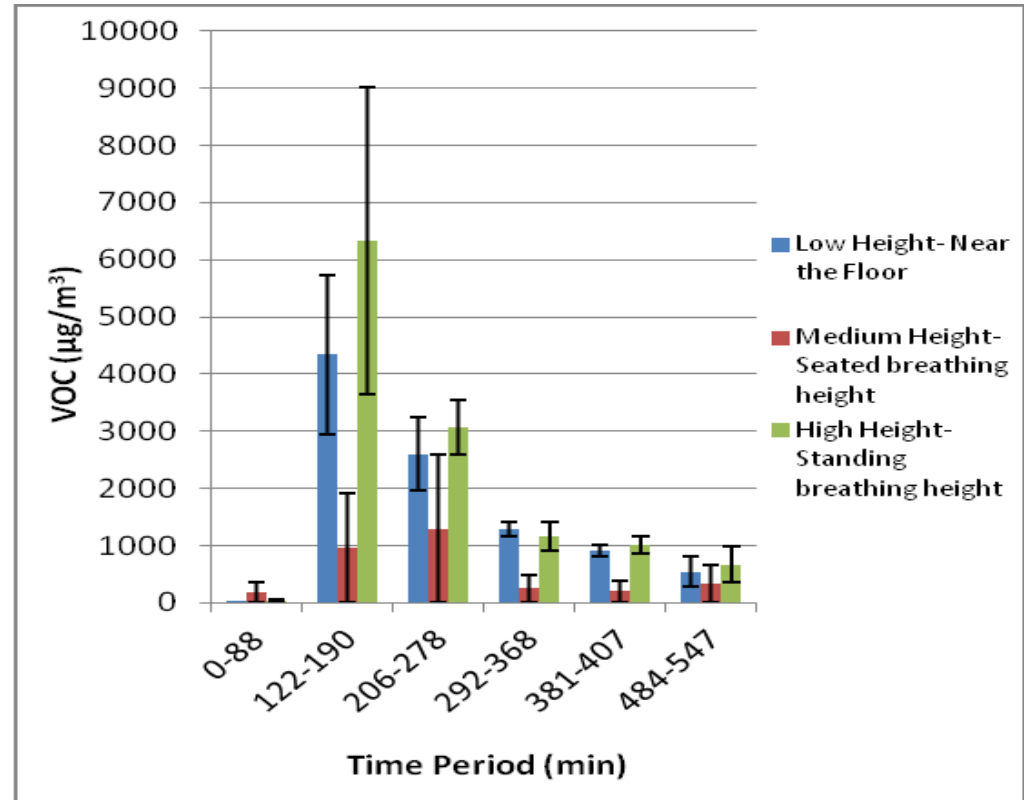




VOC Stratification

VOCs were shown to be evenly mixed in the vertical plane but not in the horizontal plane

VOC levels were significantly less at seated breathing (medium) height



Decay Equation

- CETEC: $VOC=33221\exp(-0.548t)$ with an R^2 value of 0.963.
- Fraunhofer: $VOC=7749\exp(-0.597t)$ with an R^2 value of 0.9296.



Fitout Materials – Absorption and Re-Emission

The carpet tiles and ceiling panels placed in the room absorbed significant amounts of VOC and formaldehyde.

Following the room experiment, their chamber-tested maximum averaged re-emission rates were 593[ng/(h*g)] for carpet and 1211[ng/(h*g)] for the ceiling panels.

The re-emission test chamber results were consistent between the German and Australian laboratories.

Conclusions



1. TVOC and formaldehyde decay-rates will assist in reverse-modelling following construction and occupant adverse health events.
2. Allowance has to be made for continuously emitting materials controlled by diffusive emission
3. Benefits to building designers, owners and operators to better predict when offices are safe to occupy following new fitout works.
4. VOCs layering for understanding the effect of the building material product formulation on the occupant.
5. Re-emission of VOCs absorbed onto carpet and ceiling tiles occurs long after the new-office odours have gone.
6. More research needed to understand the behaviors of the individual VOC chemicals in office air.

Implications



- This study highlights the need for a **quantitative** approach to construction activities and re-occupation, to ensure good IEQ
- Short-term VOC emissions during construction turn into long-term emissions
- VOC absorption vs “molecular decay”



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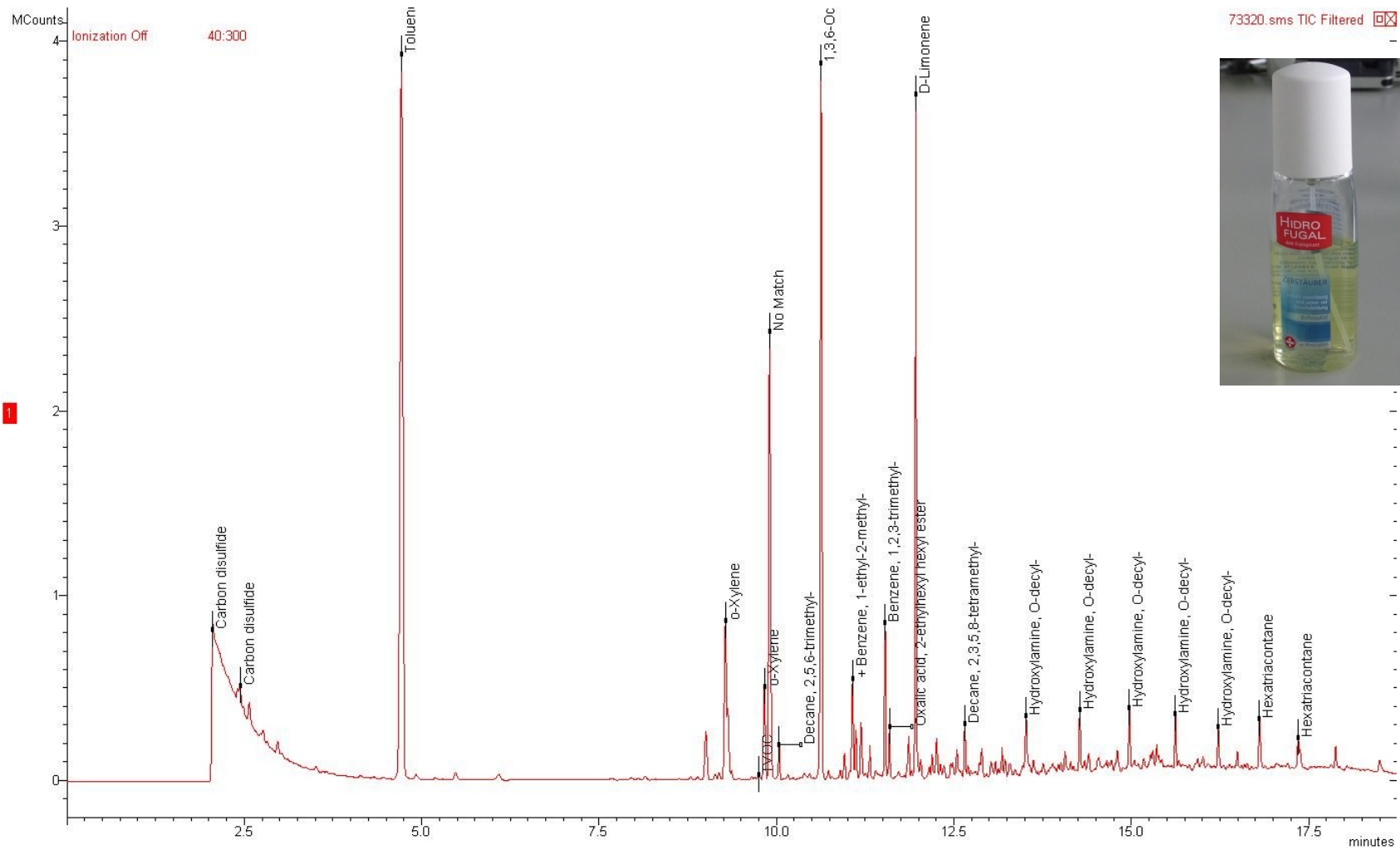
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VOC Spray



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