ventilation issues arising from post occupancy studies on new build and refurbishment projects

Tim Sharpe
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introduction

- post occupancy evaluations of;
- gilmour's close, edinburgh
- the glasgow house
gilmour's close

- a 19th century masonry tenement
  - adaptive rehabilitation
- design of low energy housing
- social rented and supported tenures
- incorporation of thermally efficient envelope, MVHR, GSHP & sunspaces
- POE of 5 dwellings & 1 office
subject dwelling arrangement

Dwelling 5

Dwelling 2

Double Bed

Twin Bed

Living Room

Sunspace

Kitchen

Sunspace

Double Bed

Living Room

Kitchen
findings - air delivery issues

Dwelling 2, Twin Bed Conditions - 17.03.11 to 12.04.11

Pettenkoffer’s max’ - 1000ppm
findings - IAQ daily profile

Dwelling 5, Living Room Conditions - 07.04.11

Temperature, & Vapour Pressure

CO₂ Concentration

Time

00:00:00 01:00:00 02:00:00 03:00:00 04:00:00 05:00:00 06:00:00 07:00:00 08:00:00 09:00:00 10:00:00 11:00:00 12:00:00 13:00:00 14:00:00 15:00:00 16:00:00 17:00:00 18:00:00 19:00:00 20:00:00 21:00:00 22:00:00 23:00:00
findings - air delivery issues

Dwelling 5

Dwelling 2
identified issues - IAQ and user behaviour

- limitation of MVHR system in dealing with pollutants
- ventilation strategy not functioning well in practice
- user behaviour in response
- incurred (double) energy penalty
subject dwelling arrangement

Dwelling 5

Dwelling 2
findings - sunspace benefits
sunspace benefits

• benefits of ventilation relationship to sunspace when considered as a buffer zone
• reduction of energy penalty in relation to occupant controlled ventilation
the glasgow house
the glasgow house

- exemplar test dwellings
- incorporating thermally efficient envelope, MVHR, sunspaces & air tightness of $3m^3/h/m^2$
- 4 test ‘residents’ per dwelling
- circa 2 week occupation
- defined occupancy script
- monitoring of physical parameters & behaviour
findings - CO\textsubscript{2} level comparison (scenario 1)

Comparison of CO\textsubscript{2} Concentration in Living Rooms A & B (Scenario 1)
findings - IAQ daily profiles

Dwelling B, Kitchen Temp/ Vapour Pressure/ CO₂ Concentration vs Time, 18.02.11

Temperature (°C) and Vapour Pressure (hPa) data along with CO₂ concentration measurements are illustrated over a 24-hour period. The graph highlights the readings taken from 00:00 to 23:00 on 18.02.11.

Key findings include:
- The maximum temperature recorded was just under 25°C.
- Vapour pressure stayed relatively stable, with slight fluctuations throughout the day.
- CO₂ concentration showed peaks during kitchen activities, aligning with the Pettenkofer’s Max threshold of 1000 ppm.
- There was a notable increase in CO₂ concentration at around 18:00, indicating a significant event, possibly related to cooking or other kitchen activities.

For a detailed analysis, please refer to the complete dataset and methodology.
findings - IAQ daily profiles

Dwelling B, Kitchen Temp/ Vapour Pressure/ CO$_2$ Concentration vs Time, 27.02.11

- **Kitchen °C**
- **Kitchen hPa**
- **Kitchen ppm**

- **Platts-Mills Max - 11.3 hPa**
- **Pettenkofer's Max - 1000 ppm**

Pettenkofer's Max - 1000 ppm
CO₂ Concentration vs Fresh Air Delivery Rate in Occupied Spaces

CO₂ Concentration (ppm) vs Delivery Rate (litres/second/person)
## Findings - Measured Air Delivery Rate

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<th>Position</th>
<th>Vel</th>
<th>Flow</th>
<th>Flow (100mm duct)</th>
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identified issues - specification and installation

- limiting factor of extract volume
- quality of installation and commissioning process
- length of delivery runs vs acoustic separation
- operational rate of system generally in relation to demand
- efficacy of boost or response to demand brought into question
identified issues - maintenance

- key consideration of position for maintenance vs occupant ability to override controls
Comparison of CO₂ Concentration in Living Rooms A & B (Scenario 2)

Date: 06/12/2011 to 16/12/2011

Comparison of CO₂ level comparison (scenario 2)
MEARU - further studies

• strong case for continued investigation and analysis
• Technology Strategy Board 2 year post occupancy evaluations
• glasgow house (further scenarios)
• scottish housing expo
• bloom court, livingston
sealing tight AND ventilating right?

- airtightness alone not a solution
- failure to consider IAQ undermines energy strategy - window opening
- gaps in understanding of the relationship between thermal performance and IAQ
- gaps in legislation for ventilation and energy use
sealing tight AND ventilating right?

- increasing complexity of technologies
- holistic thinking by architects - skills and remuneration
- specification, maintenance, education and control
- need for POE - learning from practice and research