Lessons learned from design and operation of ventilation systems in low-energy dwellings in the UK

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SUMMARY

This presentation will cover the key lessons learned from post-occupancy evaluation of the ventilation strategies in several new-build dwellings in the UK. Two ventilation strategies often used for new dwellings in the UK are mechanical extract ventilation (MEV) and whole-house balanced mechanical ventilation with heat recovery (MVHR). Few examples of the design and operation of these systems will be presented identifying the best practice and improvement opportunities for mechanical ventilation systems that are increasingly used in airtight low-energy dwellings.

Issues around system installation and commissioning may compromise energy efficiency of the air distribution system and the airflows supplied to dwellings. Measurement of air flows in new-build dwellings with MEV system showed that actual flow rates may be significantly lower than design intents if the systems are not commissioned effectively. Actual flow rates measured in boos ventilation mode were up to 30% lower than the design target.

The study also found examples of under-ventilation in dwellings with MVHR systems. In addition to system commissioning, maintenance of MVHR system including regular filter replacement is crucial to ensure adequate fresh air is provided to a dwelling. There are improvement opportunities in provision of information and training to building users about MVHR systems. It is suggested that Landlords and housing association can also take more responsibility for system inspection and maintenance in rented accommodation and social housing similar to the requirement for annual inspection of heating systems.

Finally, measurements of concentration levels of several pollutants, identified as high risk in low-energy dwellings in IEA-EBC Annex 68 programme, identified improvement opportunities for source control and enhanced ventilation to reduce concentration level of Formaldehyde to the best-practice exposure limit value. The current regulatory framework in the UK covers major outdoor sources of pollution and TVOC as a proxy for indoor sources related to construction material. However, TVOC is not the best indicator of indoor sources of air pollution and their potential health effects. It is necessary to adopt a more refined approach and address specific volatile organic compounds with potentially high adverse impact on health and well-being to protect building users and strike the right balance between energy efficiency and indoor air quality.

KEYWORDS

Post-occupancy evaluation, low-energy dwellings, Mechanical extract ventilation (MEV), Mechanical ventilation with heat recovery (MVHR), Indoor Air Quality (IAQ)

Figure 1: Examples of dwellings covered in the study: terraced houses with MEV system (left), apartments with MVHR system (right)

Table 1: Measured air flows in sample dwellings with MEV systems against design targets

Dwelling	**Total trickle extract flow rate / design target (l/s)**	**Total boost flow rate / design target (l/s)**
Mid-terrace House 1	11.7 / 30.5	34.9 / 35
Mid-terrace House 2	12.2 / 30.5	30.2 / 35
End of Terrace House	2.2 / 30.5	24.1 / 35

Table 2: Concentration levels of ley contaminants and air change rates in dwellings with MVHR system during heating season

VOC concentration (µg/m³) & Air Change rates per Hour for each zone	**APT. 3 (Block A, 9th Floor)**			**APT. 4 (Block B, Ground Floor)**			**IEA EBC Annex 68 Long Term ELV**
	Living room	Kitchen	Sample bedroom	Living room	Kitchen	Sample bedroom	
Benzene	**1.3**	**1.0**	**1.2**	**1.5**	**2.1**	**1.6**	0.2
Formaldehyde	**29.25**	**26.87**	**29.53**	**21.23**	**31.35**	**27.44**	9
Trichloroethylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2
Styrene	1.5	2.2	3.0	0.8	0.7	1.7	30
Naphthalene	**5.4**	**5.4**	**5.0**	0.9	0.9	1.3	2
Toluene	2.7	2.9	3.1	2.2	2.6	2.4	250
Tetrachloroethylene	0.6	<0.6	<0.6	1.5	1.2	1.8	100
ACH (PFT measurements)	0.50	0.52	0.76	1.02	1.14	0.6	n/a

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