Domestic Ventilation and Energy

Janice Foster

The declaration of a climate emergency and net zero-carbon legislation are driving a significant shift in improving energy efficiency in dwellings. These improvements can often increase thermal comfort and reduce annual heating costs for occupiers, but a potential downside exists that can impact the health of occupants. Lifestyle factors are often cited when building failures, such as mould growth and poor indoor air quality are present. It is hard to imagine occupants choosing such a situation. Poor housing leads to health and societal challenges, causing inequalities that potentially affect occupants throughout their lives.

In a well-designed house, ventilation removes stale air and replaces it with cleaner air from outside. When coupled with heating it can reduce the risk of condensation. We are familiar with the mantra “build tight, ventilate right”, which promotes airtightness and controllable ventilation being designed together. Both contribute towards a comfortable and healthy indoor environment, yet some designers have reservations about airtightness and a misperception that this causes poor indoor air quality and overheating. These effects are more likely to be caused by decreasing space standards, poor orientation, inappropriate location, inadequate insulation, an increase in synthetic building materials and finishes, a lack of solar shading and inappropriate window design.

When appropriately designed, insulation can help to keep a building comfortable by controlling how much heat gets in or out. A correctly orientated building can exploit passive solar energy to reduce heating input in the winter. However, the design should consider a solar shading strategy to reduce the risk of overheating and the need for artificial cooling in the summer. Both of these design strategies can reduce energy use in a building. When indoor temperatures increase, so too does the release rate of volatile organic compounds (VOC), necessitating more ventilation to maintain good indoor air quality. An airtight building additionally has a filter effect, reducing the ingress of outdoor air pollutants. If the design is considered holistically – eliminating draughts, utilising thermal and moisture mass, using non-toxic materials and vapour-open construction – there is more opportunity for the building fabric to buffer indoor conditions.

The requirement for mechanical extraction from kitchens, bathrooms and toilets – along with trickle ventilators throughout a home - was introduced to the Building (Scotland) Regulations in 1990 with the objective of removing moisture from a dwelling. This remains the predominant ventilation method in housing. Concerns over the effectiveness of this approach focus on how well extract fans and trickle vents really work. Building performance evaluation (BPE) research in to new energy-efficient housing by organisations, including MEARU (Mackintosh Environmental Architecture Research Unit), found these concerns to be partly justified. Findings included insufficient airflow rates, noise issues, poor installation and a lack of understanding by occupants for optimum operation. Trickle ventilators were poorly installed and draughty even when closed, sometimes causing occupants to tape over them.

Mechanical ventilation with heat recovery (MVHR) is often seen as a simple solution to these issues. However, the BPE work also identified poorly designed, sized and installed MVHR systems. An example of a new dwelling in Glasgow designed with an airtightness of 4m3/hr/m2 @ 50Pa had an undersized MVHR unit. This was located in the loft, meaning access – for example to change filters – to the unit could only be made by crawling under truss ties. Other issues included duct- and structure-borne noise transmission, extract ducting incorrectly connected to the living room supply air terminal and the commissioning sheet falsely indicating a balanced system. The recent inclusion in the Building Regulations for all mechanical ventilation systems to be commissioned is a welcome development.

Other ventilation design issues were identified in ground floor bedrooms where occupants felt vulnerable when sleeping at night with windows open. The consequence was that these bedrooms were rarely ventilated, which reduced opportunities for pre-cooling the building fabric. Situations such as this highlight the need for secure day and night ventilation to meet year-round ventilation needs.

Regardless of airtightness and background ventilation method, designs of all homes require adequate rapid ventilation. Opportunities for this have reduced as window design has changed dramatically, with new dwellings fitted with tilt-and-turn windows that are often full-height. While these have benefits over other fenestration arrangements, such as less frame, unobstructed view and more daylight admittance, it is more difficult to fine-tune ventilation airflow and they not always appropriate for use in all weather conditions. Successful approaches include a mix of cross-ventilation, stack ventilation, secure ventilation and purge ventilation within the design, which should be tested through computational assessment.

Reducing draughts in buildings is, without doubt, a sound principle but must be accompanied by appropriate and adequate ventilation as part of the strategy to create energy-efficient buildings. Other essential factors include attention to orientation, adequate room sizes, thermal and moisture mass, solar shading and simple occupant guidance. It is only through the consideration of these together – holistically – that healthy, energy-efficient and comfortable indoor environments will be achieved.

----