Advances in European residential ventilation systems in Nearly Zero Energy Buildings

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SUMMARY

Energy performance of buildings has been continuously and systematically improved in Europe with next step of transition to nearly zero energy buildings (NZEB) in 2019-2021. Well insulated and airtight NZEB provide challenges or opportunities – depending on point of view – for ventilation systems. Heat recovery ventilation may be expected to be major ventilation solution because in Continental and Nordic climates, it is simply impossible to build nearly zero energy buildings without heat recovery. In warmer climates, co-benefits of heat recovery ventilation units as filtration of pollen and carcinogenic particulate matter (IARC 2014) as well as sound insulation make it very strong alternative to conventional airing solutions, however this existing evidence is not yet widely accepted and understood (JRC 2016). The role of ventilation is twofold, in addition to energy saving contribution the main task of ventilation is to provide fresh air so that indoor air quality (IAQ) and thermal comfort are ensured. In well insulated and airtight buildings, the importance of controlled ventilation is stressed, because air infiltration through building envelope is practically missing and opening of windows during heating season will waste a big amount of energy. In addition to supplying proper air flow rates, balanced operation and compensation of cooker hood, fireplace or central vacuum cleaner have new meaning in airtight buildings, that can be called as a security issue: if not properly designed for instance children are not able to open doors because of high pressure differences.

Wider application of heat recovery ventilation brings attention to knowledge and regulatory gaps which call for research and other actions. In EU level there have currently been no binding ventilation and IEQ requirements. From a regulatory point of view these remain under the competencies and responsibilities of the EU Member States, but the situation is changing. In the recent review process of Energy Performance of Buildings Directive (EPBD), the assessment of the implementation status of the EPBD by the EU MS in terms of ventilation and indoor air quality criteria was conducted by European Commission Joint Research Center (JRC 2016). This assessment confirmed that there still exist MS without binding ventilation requirements and many inadequate ventilation problems have been reported especially from renovations, where insulation, improvement of air tightness and replacement of windows has often stopped air change because adequate ventilation systems have not been installed. On the other hand, the scientific literature review done by JRC (2016) provided new evidence that mechanical heat recovery ventilation systems have led to an overall improvement of the IAQ and reduction of reported comfort and health related problems if properly designed and operated. This reveals that highly performing and healthy buildings do exist in EU and have improved occupant comfort and satisfaction. Revised EPBD stresses the importance of ventilation by requiring adequate ventilation in order to optimise health, IAQ and comfort levels defined by MS, which provides clear mandate to MS to establish minimum ventilation requirements for new buildings and major renovations to implement the directive.

In many technical questions there is no consensus in national regulations of EU Member States (MS). This applies for instance for air flow rates, i.e. how much ventilation is needed, restrictions of the use of some heat exchangers types, connection of cooker hoods to ventilation system and placement of exhaust air devices. While European standards are well detailed in these aspects for non-residential ventilation, there is very limited information available for residential ventilation systems. Recent European Guidebook (REHVA GB No 25) have made an attempt to collect evidence based best practice technical solutions and design principles for residential ventilation. Still huge research need remains, experience of the use of advanced ventilation systems is needed for further development of components, system solutions, control and operation strategies as well as proper sizing.

Selection of air flow rates in dwellings has recently been updated in European and ISO standards (EN 15251, prEN 16798-1, ISO 17772-1:2017). However, the use of these standards in the sizing of air flow rates is not straightforward, because standards provide airflows in several indoor climate categories and supply air flow rates are given in L/s per person, while the number of occupants is typically not known information in the design. REHVA GB No 25 has made a step forward by developing a room-based airflow rate selection procedure providing L/s per room values for different type or size of rooms, which are calculated with default occupant density range and indoor climate category II assumptions. While this guidebook recommends continuous operation of residential ventilation as a robust and reliable solution where are many technical solutions available for demand-controlled ventilation. Recent research has revealed that demand-controlled ventilation should be controlled in addition to bioeffluents and humidity generation also by other emission sources (VOC etc.) which do exist all the time. When these sources are taken into account much longer ventilation operation is needed compared to simple CO_2 control. Walker and Brennan (2008) have shown that instead of 40% energy saving only the saving in between 0-8% can be achieved depending on occupancy pattern and climate.

Air flow selection can be seen as an important, but only the first step in ventilation system configuration selection and system sizing. General principle of source control first, means that wet rooms are to be equipped with extracts and kitchens with cooker hoods. Supply air to living rooms and bedrooms has to be transferred and removed by these extracts. If conventional cooker hoods with their own exhaust fans are used, very high negative pressures up to 200 Pa may be generated in airtight apartments. To avoid this, cooker hoods need to be compensated in order to ensure balanced operation. This can be done by connecting cooker hood to ventilation unit, in the case plate heat exchanger the airflow from cooker hood will go through heat exchanger, but rotary heat exchangers are to be bypassed to avoid carry over of contaminants and to keep wheels clean. Best practice solutions how to boost ventilation during cooker hood operation are reported in REHVA GB No 25. This guidebook has also made an attempt to solve a complicated issue of noise calculation. Simple diagrams developed inform practitioners how much sound attenuation is needed to achieve silent operation of ventilation.

As a conclusion, there is no conflict between good indoor climate and energy efficiency targets in airtight buildings if heat recovery ventilation is used. NZEB requirements provide new opportunities for dedicated ventilation systems and also a lot of research and harmonisation is needed in order to ensure robust and reliable operation of ventilation satisfying high level of occupant health and comfort requirements.

KEYWORDS

Ventilation, Residential, Heat recovery, Cooker hood, Controls

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