Effect of Indoor Temperature Differences and Zoning on the Performance of Energy Efficient Ventilation Strategies for Domestic Buildings

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ABSTRACT

In this presentation, I will present an evaluation of the impact of the indoor temperature gradients on the energy performance of the ventilation in dwellings. Research reported in literature suggests that the temperatures of the different zones in a dwelling could have an impact on the expected effect of ventilation on the energy performance of residential buildings. This research reported a gap between energy performance indicators measured in actual dwellings and the same indicators predicted by EPBD related calculation methods, which use a single indoor temperature. This work does not intent to make an analysis of those calculation methods or to be considered as a reference for a possible comparison with them. Instead, we focus on the evaluation of the impact of the temperature gradients using dynamic simulations.
To evaluate the energy performance of ventilation, we propose to use the ventilation heating demand coverage ratio (η_IV) that expresses how much of the surplus heating demand caused by the installation of a non energy efficient ventilation system is compensated by the installation of one or more strategies to reduce ventilation heat losses: heat exchanger(s), demand controlled ventilation strategy (DCV) or both. This coefficient is calculated using the annual heating demand of three scenarios: 1) The no ventilation scenario (NV), representing a dwelling without a ventilation system and, consequently, null (intended) ventilation heat losses; 2) the characteristic ventilation scenario (CV), representing a dwelling with a ventilation system that works with its characteristic controls and heat recovery (HR) function (if available); and 3) the maximum flowrates no heat recovery scenario (MFNHR), representing the CV scenario without heat recovery and working as a constant air volume ventilation system (CAV) with flowrates at the design flowrates defined for each dwelling. To see the influence of temperature gradients, the coefficients is calculated for two different heating strategies (uniform and non-uniform) and are compared in the form of a ratio, called the uniformity effect indicator.
The indicator is calculated based on data from dynamic building energy simulations (BES) built in Modelica that cover representative cases in Belgium, Ireland and the Netherlands. This work is focused on instances of VST3, VST4, VST5 and VST7 as defined by The European Ventilation Industry Association (EVIA), including variants of these systems using demand control (DCV). The studied cases are representative of the typical dwellings in the countries observed in this study and representative examples of the ventilation systems available in the market. However, the conditioning system is idealised and not representative of an existing solution, as the intent of the study is focused on the impact of the studied conditions on the energy performance related to ventilation. The coefficients are focused on heating, but they are extended to also consider cooling.
The general conclusion is that the energy performance as expressed by the ventilation heating demand coverage ratio is slightly better under uniform temperature conditions, but the differences are below 10 % for heating and cooling, looking at the interquartile ranges (which contain 50 % of the values). Depending on the case, the median of the uniformity effect indicator in heating can oscillate around the unit, in general between 0.94 (better under uniform conditions) and 1.03 (better under non uniform conditions). For cooling, the values oscillate around 0.95 and 1.01.

KEYWORDS

Ventilation, Zoning, Residential, Demand Control, Heat recovery