Challenges and limitations of performance based approaches: the Belgian experience

Samuel Caillou[1], Sébastien Pecceu[*1]

1 Belgian Building Research Institute (BBRI)
Brussel, Belgium
* sebastien.pecceu@bbri.be

KEYWORDS

Demand controlled ventilation, IAQ criteria, performance based approach.

INTRODUCTION

Performance based approached for ventilation started to be used in Belgium in 2008 in the context of EP regulation. Until 2015, demand controlled ventilation (DCV) systems were considered as “innovative” products and were not directly taken into account in the EP calculation method. Their energy performance was then considered through a principle of equivalency. A first performance based approach was developed in this frame.

As DCV systems became more and more common, it became considered as a “mature” technology and then was included in the basis EP calculation method in 2015. The reduction factors of the method were determined using an updated method based on the existing equivalency approach.

This experience has been then used in many research projects. Among these projects, the recent PREVENT project aimed at the elaboration of new performance criteria and design rules (simplified rules) for ventilation systems in dwellings. This project emphasized also the need, in complement to simplified rules easily applied for simple systems, to have performance based approaches to be able to evaluate the performances (IAQ and Energy) of some more complex systems, such as natural ventilation systems, some DCV systems, etc. Performance criteria were used to compare different ventilation systems, whether they were using DCV or not.

The challenges are however still big and experience acquired through these various steps are of great value. The aim of this paper is to illustrate some challenges and limitations of such performance based approaches for ventilation system.

SIMULATION METHODOLOGY

The simulation methodology used in the equivalency principle in Belgium has evolved with time and the complexity of the systems which have been tested. The last evolvements of this method has already be described (Caillou, Laverge, Van Gaever, & Janssens, 2014) (Pecceu, Caillou, & Van Gaever, 2018) and the main common principles can be summarized as follows.

- The simulations are carried out on model dwelling using the simulation software CONTAM.
- The used IAQ metrics are cumulated CO_2 exposure of occupants and risks of condensation based on RH in service spaces

The IAQ criteria and energy references have evolved with time, from an absolute, but weak, IAQ criteria and a fixed flow rate in the first methodology to a trade-off approach combining IAQ and energy evaluation together in the last evolution steps of the methodology.

However, one of the challenges of this methodology was that the ventilation systems prescribed in the current ventilation standard in Belgium (NBN D 50-001) were not necessarily equivalent regarding IAQ and flow rate performances.

CHALLENGES AND LIMITATIONS: ILLUSTRATION FROM EXAMPLES

We choose to illustrate the challenges and limitation by several examples encountered at various steps in the above-mentioned history.

- Natural ventilation system with DCV

A first example concerns a natural system (natural exhaust and supply – A system in the Belgian Standard). In this example, a natural exhaust opening controlled by humidity in the service lead to a lower CO_2 exposure (better IAQ) for the occupants in the living spaces, while average flow rate at building scale was lower than for the system at full capacity.

Analysis showed that the controlled exhaust in closed position indirectly redirects the flow rate to the living spaces at the first floor, where the air is leaving the building rather than entering but resulting in a higher air change rate in these rooms. The improvement is in fact mainly due to the poor performance of the not controlled system used as reference.

- Mechanical exhaust ventilation (MEV) with DCV based on RH in service spaces

With an absolute and weak IAQ criteria in the first versions of the methodology, using a RH detection in service spaces lead to a significant flow rate reduction compared to a constant flow system. This translated into a significant advantage in the EP calculation, but with a decrease in IAQ (while still respecting the absolute criteria).

In a latter version, using the reference curve approach (considering both flow rate reduction and IAQ, see "Methodology), one showed that this type of regulation presents no advantage compared to a constant flow rate ventilation.

- Mechanical exhaust ventilation (MEV) with CO_2 controllable supply grid in the day zone

In the studied case, this system with a CO_2 controllable grid in the day zone allowed to better control the fresh air supply in the bedrooms in the night zone. This system was particularly effective, compared to the reference MEV, in an airtight model dwelling with the day and the night zones opened on each other via a common hallway (as considered in the basis methodology).

However, more detailed analysis showed that this advantage decreased when the day and night zones were closed on each other, and was completely loosed, compared to the reference MEV, when theses zones are separated by an airtight partition.

- MEV system with supply grid on roof pane

Supply grid should normally be on walls but are sometimes placed on roof panes in specific configurations (e.g. attic transformed in bedroom). For non-airtight building, simulations showed that the CO_2 exposure in these conditions is quite low (good IAQ), but it is mainly because the flow is going out through the inlet grid (due to wind under pressure). This is not the expected working of the system, and it is well possible that air from the service spaces or the living room is transferred to this bedroom. This is not covered by the used criteria.

CONCLUSIONS

All these examples illustrate the main challenges to solve in order set-up a relevant performance based approach for ventilation systems

- The difficulty to consider both energy and IAQ at the same time
- The risks and difficulties inherent to the use of an absolute criteria (definition and threshold) or a relative criterion (strongly dependent of the reference(s))
- The possibility that the criteria miss some aspects, or inversely the possible multiplication of criteria to cover all aspects.

REFERENCES

Caillou, S., Laverge, J., Van Gaever, R., & Janssens, A. (2014). Méthode de calcul PER - Facteurs de réduction pour la ventilation à la demande.

Pecceu, S., Caillou, S., & Van Gaever, R. (2018). Demand Controlled Ventilation: relevance of Humidity Based Detection Systems for the Control of Ventilation in the Spaces Occupied by Persons. *AIVC.*