Demand controlled ventilation: Sensitivity and robustness of the performances

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SUMMARY

Demand controlled ventilation (DCV) seems to be the main way to comply with both energy and internal air quality (IAQ) concerns. Largely spread in non-residential building since more than 2 decades (Fisk, 1998) because of large potential energy savings, its application for the residential sector is nowadays becoming the basis of ventilation systems for dwellings. Indeed, thermal regulations for residential buildings in several countries give targets that are difficult to reach with constant air changes rates. In France, the successive higher thermal regulation requirements have led to the development of humidity based DCV systems. Since a decade, it is considered as the reference system of ventilation.
DCV strategy are developed under performance targets in order to reach threshold values for IAQ evaluation while minimising the energy impact. The performance based approach in France consist in making multizone simulation for each type of dwelling with fixed parameters. These lasts are the envelope leakage in each zone, the weather conditions (pressure coefficient, wind velocity and direction, temperature, external humidity), the domestic activities and occupant presence in the different zones.
These fixed parameters enable to make objective evaluation between two systems and thus quantify the performance of each system. The inconvenient of such approach, and mainly the deterministic parameters used, is that DCV strategies are optimized for these specific cases and thus the DCV strategy might be less effective in real situation than the numerical ones.
The present study aim to identify the global sensitivity of the DCV performance on these deterministic parameters. RBD FAST global sensitivity analysis is realized on a specific building configuration with a specific DCV system that comply with today French thresholds targets. Analyses are realized dynamically and thus integrates weather conditions variability on the sensitivity indexes. The most important parameters are highlighted as well as the influence of external conditions on the main indexes. Even though DCV strategy enable to comply with both IAQ and energy targets, their performances might be not guarantee for any cases for both, occupancy and building characteristics. Thus, the next issues migth be, how DCV could be more resilient in the future.

KEYWORDS

Demand controlled ventilation, sensitivity analyses, RDB FAST

1 METHODS

1.1 Studied case

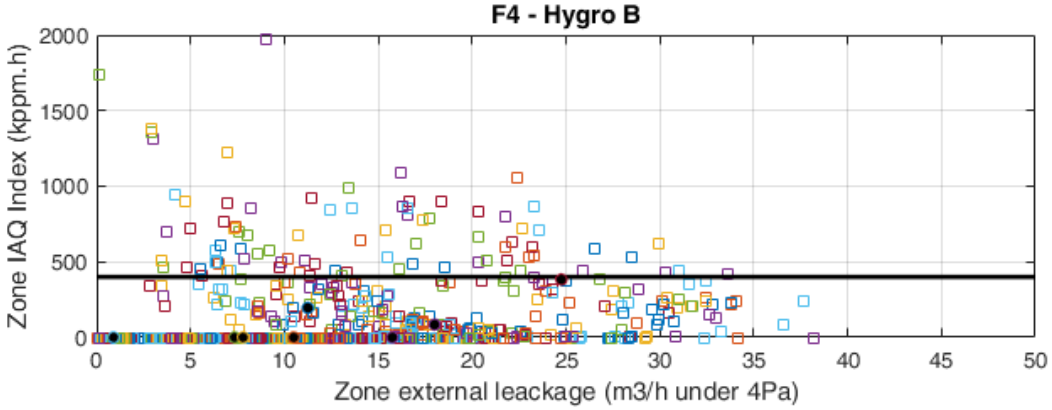
This study is realized on a F4 type dwelling with two levels. It consist in a kitchen and living room in the first floor. Three bedrooms, bath room ad toilet are in the second floor. A common hall enable the link between the two floors. The building characteristics, occupancy, domestic activities follow the recommendation of the French evaluation [CCFAT, 2017].

1.2 Methods

Global sensitivity analyse is used to identify the first order indexes of the studied parameters on a specific outputs. Several outputs are considered in this study as well as the global value that should comply with the evaluation thresholds in the French protocol.
Fourier Amplitude Sensitivity Test (FAST) is realized on the studied case presented above. FAST consist in analysing the impact of several parameters in the frequency domain. A pool of simulation runs is realized modifying, for each, the different parameter's value. Analyses are then realized at each time step along the number of runs axis.
In order to limit the number of simulation, the RBD FAST methods is used. It enable to considerably reduce the number of simulation needed to evaluate the first order indexes. More information on this specific methods can be found in [Sobol (1993), Mara (2009)].

2 RESULTS

The figure below presents, on the same studied case the impact of the zone leakage on the threshold value for several runs with randomly distributed leakage, keeping identical the global building leakage. The French threshold value is highlighted by the black horizontal line. The influence of the leakage is highlight but is not the only important element that influences this computed IAQ Index as shown by the several uncorrelated points in the figure: even for high leakage value, IAQ isn't satisfied.



These present study aim into identifying, in a first part, for which external conditions the leakage can be the most important parameter. In a second part, between other parameters as wind pressure coefficient assumptions, occupancy, internal leakage, who is the most important and for which conditions on several time dependent outputs as well as global outputs such as the one that should comply with the threshold in the French evaluation protocol. Analyses and discussion are proposed around these methods and results.

3 REFERENCES

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