Summary of the airtightness track

The AIVC – TightVent - venticool 2019 joint Conference "From Energy crisis to sustainable indoor climate – 40 years of AIVC", co-organized by Ghent University and the International Network on Ventilation and Energy Performance (INIVE) on behalf of the Air Infiltration and Ventilation Centre (AIVC), the Building and Ductwork Airtightness Platform (TightVent Europe), and the international platform for ventilative cooling (venticool), was held on 15-16 October in Ghent, Belgium. The event drew just over 200 participants - researchers, engineers & architects, policy makers or regulatory bodies, manufacturers & stakeholders and international organizations from 28 countries.

The programme included 3 parallel tracks of structured sessions with around 160 presentations covering the main conference topics namely: Smart Ventilation, Indoor Air Quality (IAQ) and Health relationships; Airtightness; Ventilative cooling – Resilient cooling. A special session i.e. "90 seconds industry presentations" was also organized and devoted to the sponsors of the event.

The Conference featured the official inauguration of the Indoor Environmental Quality Global Alliance (IEQ-GA) association during a ceremony held on the evening of the first day of the event. At the ceremony, the founding members celebrated with short speeches the establishment of the association and presented its mission and objectives to create a healthier indoor environment in the buildings sector.

The event has also been a major discussion place for on-going or recently launched projects such as, the IEA EBC annex 68 "Design and Operational Strategies for High IAQ in Low Energy Buildings" (http://www.iea-ebc-annex68.org/), the IEA EBC annex 78 "Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications"(http://annex78.iea-ebc.org/), the IEA EBC annex 79 "Occupant-Centric Building Design and Operation" (http://annex79.iea-ebc.org/) and the IEA EBC annex 80 "Resilient Cooling" (http://annex80.iea-ebc.org/).

The article available here presents main trends, ideas, considerations and conclusions that emerged from the two days of the conference on the topic of building & ductwork airtightness. The "Airtightness" track of the AIVC 2019 conference consisted of 24 presentations. Selected presentations are grouped into 3 main themes:

1. Airtightness measurements, alternative methods & wind impact
2. Durability of airtightness &
3. Modelling of infiltration

(Poza-Casado, Meiss, Padilla-Marcos, & Feijó-Muñoz, 2019) & (Berthault, Labat, Delahais, Héberlé, & Talon, 2019) focused on airtightness measurement data. (Poza-Casado, Meiss, Padilla-Marcos, & Feijó-Muñoz, 2019) performed an analysis of more than 400 blower door tests in order to assess the energy impact of uncontrolled air flows through the building envelope in residential buildings in Spain. Obtained results showed great potential for energy saving in the country. (Berthault, Labat, Delahais, Héberlé, & Talon, 2019) processed data coming from Cerema's airtightness measurement campaign in 117 multi-family collective and single-family French dwellings built before 2005 (before the release of the fifth French thermal regulation for new dwellings), with the aim to give a clear picture to the French Ministry of Sustainable Development of airtightness and ventilation performance of the existing building stock.

(Rolfsmeier, 2019) looked into the airtightness measuring procedure of very airtight buildings to provide recommendations on how to achieve reliable and repeatable measuring results. It appears that measuring very airtight buildings is time consuming and recording the measuring values requires a different approach compared to less airtight buildings.

The United Kingdom uses a dwelling energy model, known as the Standard Assessment Procedure (SAP), which utilizes a process where the measured air permeability value (q50), is simply divided by 20 to provide an infiltration rate. (Vega Pasos, Zheng, Gillott, & Wood, 2019) compared between infiltration rate predictions using the "divide-by-20 rule of thumb" and real measurements (i.e. blower door & tracer gas decay) and found errors higher than 225% in more than half of the tested dwellings with the most significant differences seen in the dwellings with more airtight building envelopes.

There were several papers dealing with the performance of the pulse method to determine airtightness, looking at different possible error sources and comparing to the blower door method (Hsu, et al., 2019), (Hsu, et al., 2019), (Zheng, Smith, Moring, & Wood, 2019). In (Hsu, et al., 2019) experimental work was conducted in a five-bedroom detached house to verify whether a uniform indoor pressure distribution can be achieved during the pulse pressurization process. According to the results, a good uniformity of the pressure distribution across the five rooms during the pulse release was achieved. A method for measuring airtightness with the AirTightnessTester (ATT) device was also presented which uses the buildings ventilation system as 'blower door' (Lanooy, Bink, Kornaat, & Borsboom, 2019).

Figure 1: PULSE-60 unit with control box (Hsu, et al., 2019)

Figure 2: Energy Conservatory duct blaster series B (Hsu, et al., 2019)

Another alternative for investigating airtightness are acoustical techniques. A new method using a high-frequency impulse response technique to identify leakage sizes is under development (Kölsch, Schiricke, Schmiedt, & Hoffschmidt, 2019). This technique has the potential to point at significant leaks during a building renovation and save building owners time and costs by focusing only on the main source of flowrate.

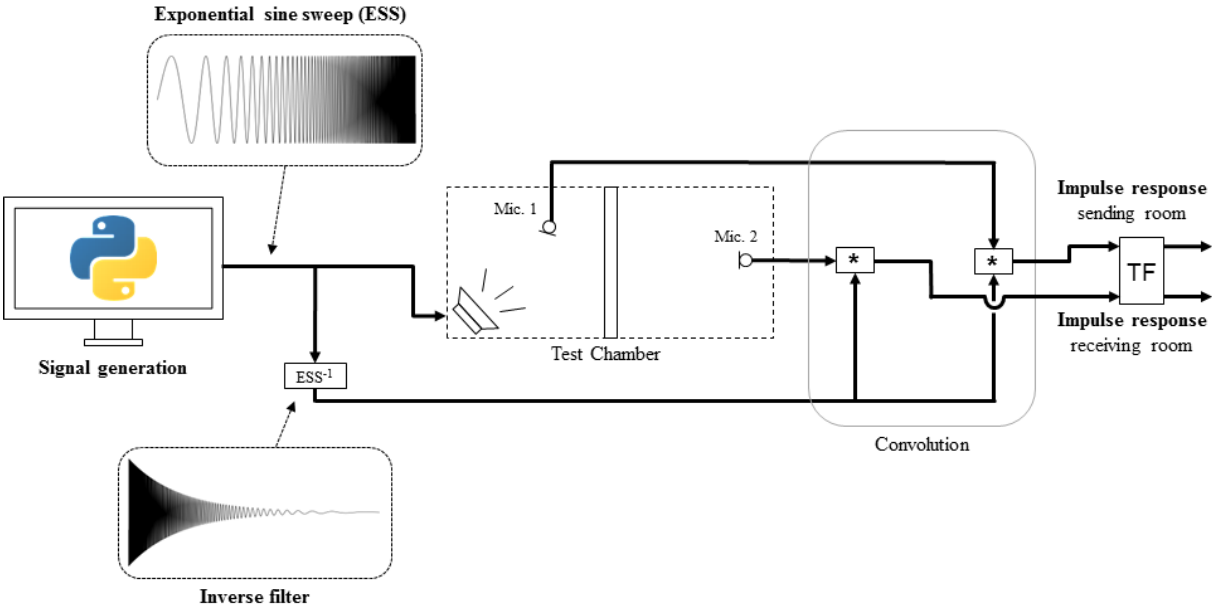

Figure 3: Measurement procedure (Kölsch, Schiricke, Schmiedt, & Hoffschmidt, 2019)

(Leprince, Delmotte, & Caré, 2019) evaluated the need for calibration of the blower door fan (fan deviation over years) through the analysis of calibration certificates issued by certified bodies. Flowrates measured by fans tend to increase slightly over time and 10% of studied certificates have at least 1 configuration[1] that does not comply with the French requirement (Maximum Permissible Measurement Error). However, the study stresses the need for a good calibration rather than a high-frequency one. It has also shown that the way the fan is handled and stored has an impact on the deviation.

Understanding the real influence of wind allows for a better estimation of the measurement uncertainty and has thus the potential to improve the measurement technique. A full-scale experiment was conducted by (Novák, 2019), in order to quantify the variability of the airtightness test results obtained under repeatability conditions with different external pressure tap positions in function of the wind speed. Along the same line, a study by (Delmotte, 2019) explained why it is necessary to use static pressure taps and place them away from the building and possible obstacles. Another study, aimed to quantify the uncertainty in zero flow pressure approximation by statistically analyzing the uncertainty indicator of 40 zero-flow pressure tests performed on 30 different units on eight different sites in Brussels (Prignon, Dawans, & van Moeseke, 2019). The impact of steady wind on building air leakage measurements was also assessed through the design of a model-scale experiment, in an effort to increase the reliability of building air leakage measurements results regarding steady wind impact (Mélois, et al., 2019).

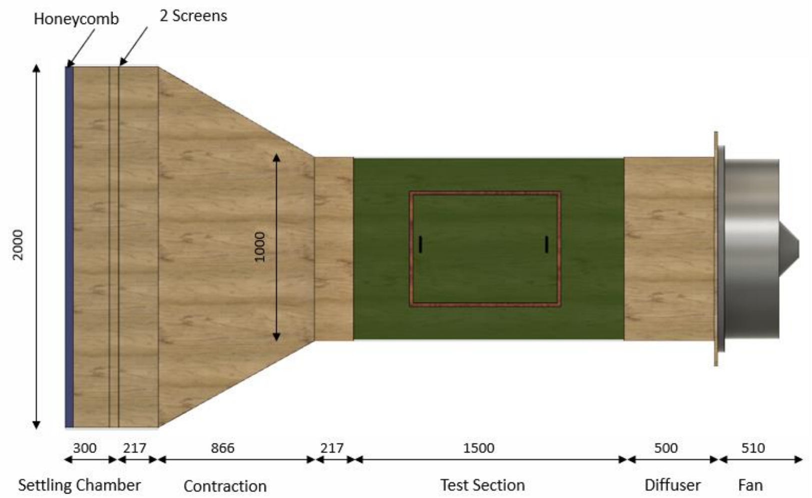

Figure 4: Final dimension of wind tunnel [in mm] (Mélois, et al., 2019)

(Moujalled, Berthault, Litvak, Leprince, & Frances, 2019), (Litvak, Allègre, Moujalled, & Leprince, 2019) & (Wahlgren & Domhagen, 2019) focused on the durability of airtightness. (Moujalled, Berthault, Litvak, Leprince, & Frances, 2019) performed an assessment of long- term (evolution of building airtightness of existing dwellings over a longer period from 5 to 10 years) and mid-term (yearly evolution of building airtightness of new dwellings over a 3-year period) building airtightness durability, through field measurements of 61 French low energy single -family dwellings. The results showed that in average the airtightness of houses deteriorates mainly during the first two years and then tends to stabilise.

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[1] In order to measure a wide range of flowrates, a BlowerDoor fan usually has various configurations (ring, plates or plugs positioned in front of the fan); during a calibration each configuration is tested

(Litvak, Allègre, Moujalled, & Leprince, 2019) focused on the assessment of the durability of airtightness products in controlled conditions through the development of a laboratory experimental protocol for characterizing the accelerated ageing of building airtightness assembled products. The objective was to define and develop an experimental protocol capable of testing and quantifying the airtightness evolution of assembled airtightness products samples and comparing the relative ageing of the samples. Figure 5 shows that the flowrate at 150Pa has increased by 25% after the sample has been subjected to the ageing protocol.

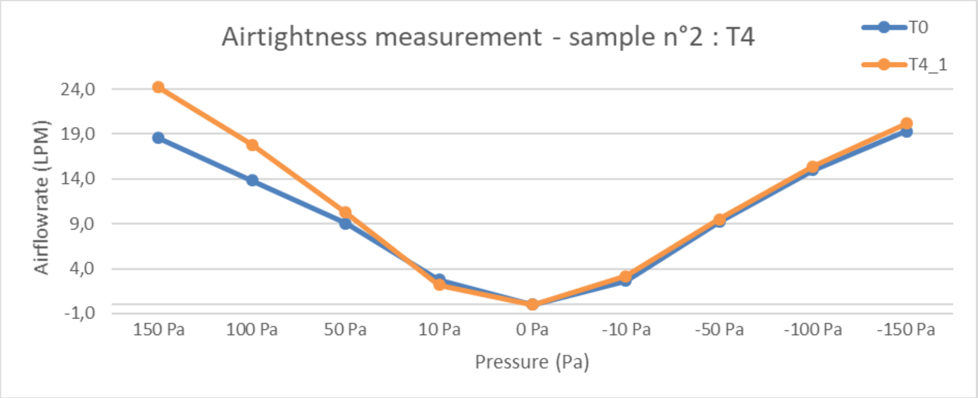

Figure 5: Evolution of air permeability flowrates, for airtightness made with backer rod and mastic (sealant) on wooden carpentry, before (T0) and after the ageing protocol (T4) (Litvak, Allègre, Moujalled, & Leprince, 2019)

(Wahlgren & Domhagen, 2019) investigated the air leakages that occur in wooden buildings from seasonal variations in climate and from finished construction (first airtightness measurement) to equilibrium (when inbuilt moisture has dried out). Measurements were made in real buildings (full scale) and in laboratory (climate chamber). The full-scale measurements on buildings with wooden construction have shown magnitudes of up to 10% increase in air leakage (at 50 Pa) for the seasonal variations and the increase for reaching equilibrium in a newly built construction is 20%.

Over the past 20 years infiltration modelling has seen small incremental improvements (such as better superposition techniques for simplified models) and integration of these models developed in the 80’s and 90’s into specific applications, such as building energy and IAQ regulations (Walker, 2019).

(Pietrzyk, 2019) gave a short overview of the probabilistic model PROMO (launched in 2000) designated to estimate the probability of insufficient air exchange or excessive heat loss. The model allowed estimation of the effect of variations of climate conditions on air exchange in a building, but also on the building energy performance. An extension of the model was proposed, which includes rapid pressure fluctuations on the air change rate based on the spectral data.

(Vega Pasos, Zheng, Jones, Gillott, & Wood, 2019) & (Rogers, 2019) investigated how to model/calculate infiltration in the best way. (Vega Pasos, Zheng, Jones, Gillott, & Wood, 2019) studied DOMVENT3D, an infiltration model that predicts the infiltration rate from air permeability measurements quoted at 50 Pa, used to calculate the English housing stock infiltration rates. An experimental validation of the predicting model was performed through a comparison with real measurements (using blower door at 50 Pa and the Pulse method). Moreover, (Rogers, 2019) looked into how accurate an extrapolation from leakage measurements is, taken at higher pressures to leakage occurring naturally at a few Pascals. The results showed that the power-law fits accurately to predict leakage near the test pressures, while at much lower pressures the true leakage might be higher or lower than the power law fit predicts and the error associated with this extrapolation might be quite large.

(Persily, Ng, Dols, & Emmerich, 2019) reviewed methods for estimating commercial building infiltration rates going back to the 1970s with a focus on how energy analysis tools (i.e., EnergyPlus) treat infiltration. More recent approaches using correlations based on a large number of multizone airflow model simulations were presented as a more feasible approach. The speaker also discussed more complex and presumably more accurate methods of accounting for the energy impacts of infiltration in commercial buildings, based on coupled airflow and energy analysis models.

(Leprince, Lightfoot, & de Jong, 2019) calculated the impact of ductwork leakage on the fan energy use of central mechanical ventilation units with heat recovery in 4 single houses with different ductwork systems, hygienic flow rates and pressure drops and explained why fan energy use & sound pressure levels increase with ductwork leakage. They conclude that poor ductwork airtightness can more than double the fan energy use and induce uncomfortable sound pressure in bedrooms and living rooms.

Note: All cited papers will be available on AIVC's AIRBASE (https://www.aivc.org/resources/collectionpublications/aivc-conference-proceedings-presentations) in March 2020

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