Summary of the "Smart Ventilation, IAQ & Health" 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 Smart Ventilation, IAQ & Health.

Studies on *smart ventilation* themes have attempted to use cloud data to improve their performance, or to use sensors to moderate the performance of a ventilation system (such as amending the airflow and recirculation rates) so that it only delivers conditioned fresh air when it is required. During the session *"Reducing exposure to outdoor pollutants"*, an interesting discussion on filtration covered the need for a new synthetic dust to test filter performance (Marval, Medina, Norata, & Tronville, 2019), and appropriate filter choices in mechanical ventilation with heat recovery (MVHR) dwellings (Rojas, 2019).

Annex 68 has been investigating Indoor Air Quality Design and Control in Low Energy Residential Buildings for the past few years and its final report is due imminently. The topical session *"Ventilation design and control in residences - current challenges, innovative solutions and case studies gathered by IEA-EBC Annex 68"* looked at large scale monitoring of demand controlled ventilation (DCV) in French homes (Guyot, 2019) and MVHR in UK dwellings as well as the measurement of formaldehyde in Chinese dwellings (Burman, 2019) (Burman & Stamp, 2019). Familiar problems were highlighted, such as the lack of training for occupants in the complex systems that ventilated their homes, and a lack of responsibility for their maintenance. Health metrics were also discussed, particularly exposure limit values (Burman & Stamp, 2019).

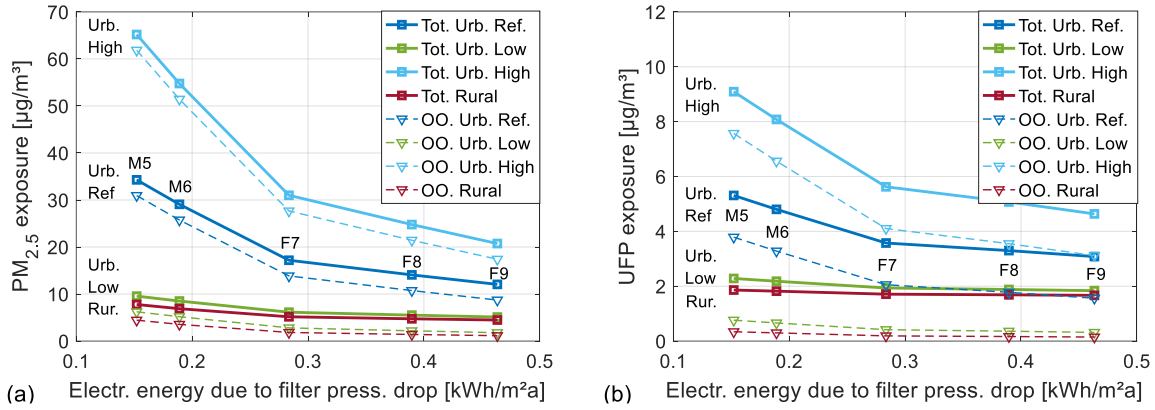

Figure 1: Average PM2.5 (a) and UFP (b) exposure as a function of the electric energy consumption of the fan related to the pressure drop of the filter for different outdoor PM concentrations. The units refer to kWh per m² of floor area and year, assuming permanent fan operation. The contribution of the outdoor originated (OO) PM is also plotted (dashed lines) (Rojas, 2019).

The session *"Indoor Environmental Quality (IEQ) field studies"*, included studies in Australian schools (Haddad, et al., 2019) and social homes (Haddad, Synnefa, Paolini, & Santamouris, 2019), Canadian schools (Tardif & Brideau, 2019), Chilean homes (Molina, Jackson, & Jones, 2019), and low energy homes in California (Walker, Singer, & Chan, 2019). Speakers also dealt with energy poverty issues (13.2% of the Australian population (Haddad, Synnefa, Paolini, & Santamouris, 2019) and 60% in southern Chile (Molina, Jackson, & Jones, 2019)) and the inequality of IEQ environments by social economic status. It should be highlighted that SF6 is still being used as tracer gas but due to its high global warming potential (GWP) of >24,000:1 it has been banned in many places already; it seems evident that SF6 should not be used for any application.

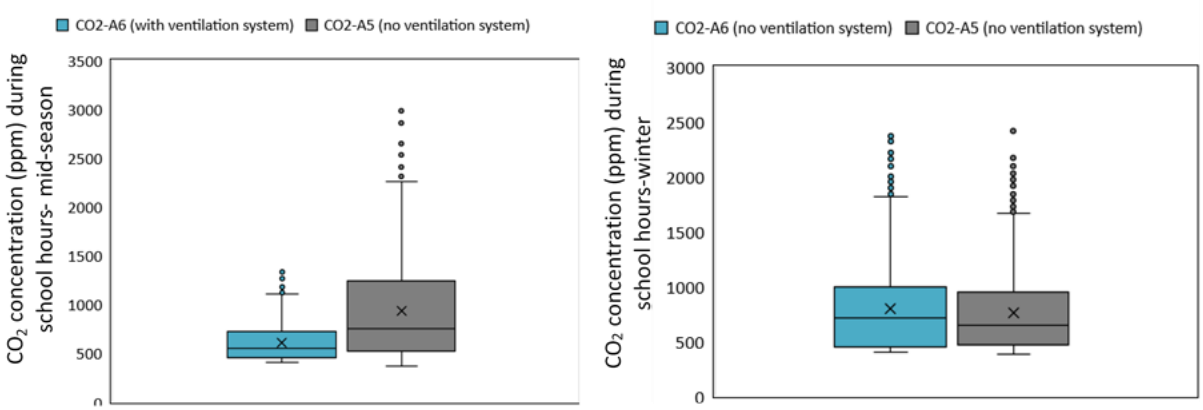

Figure 1: Box plot of CO2 after (left) and before (right) installation of the ventilation system (Haddad, et al., 2019)

Another topical session on *"Performance-based assessment methods for ventilation systems"* presented existing approaches in different countries. According to the speakers, Spain already has performance based ventilation systems since 2017 (Linares & García, 2019) while France is considering a framework for demand controlled ventilation (Parsy & Guyot, 2019). Furthermore, the Belgians have some experiences of deriving performance metrics using CO2, odours and humidity (Caillou & Pecceu, 2019), and it is possible to use sensitivity analysis to determine the change in sensitivity over time of an output to measured parameters (Faure, 2019).

The relationships between relative humidity, surface moisture and mould were discussed in depth in the topical session *"Controlling moisture for improved IAQ"* and in several other sessions too. Mould may be present even when we can't see or smell it, although smell is a good indicator of potential harm.

The ability to measure and record data using cheaper Wi-Fi-connected sensors located in systems (Lokere, et al., 2019) means that we can evaluate the likelihood of mould growth and develop or implement mitigation measures. However, our ability to predict mould growth (Vanpachtenbeke, et al., 2019) is limited because we tend to use one model to estimate the growth of all moulds.

ByggaF is a method to ensure moisture safety in the construction process (Mjörnell & Gustavsson, 2019). It applies at different stages of the construction phase and the operation and management phase. It was adopted by the Swedish construction industry and is now a standard. It can be applied outside of Sweden, but national conditions and regulations need to be considered. The next stage is to digitize it.

We sleep for more than 20 years of our lives (Wargocki, 2019). High quality sleep is vital for people and improves cognitive performance, reduces health risks (dementia and Alzheimer's) regulates hunger, improves concentration and performance (Wargocki, 2019). Sleep deprivation is on the increase (<7.5h) (Wargocki, 2019).

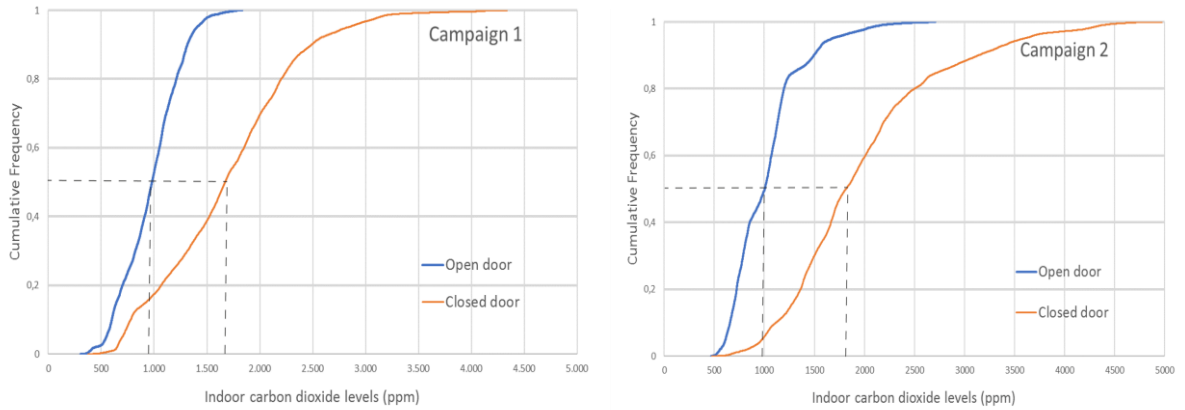

Figure 2: Results of CO2 concentrations monitoring campaigns (Wargocki, 2019)

During the session *"Bedroom ventilation, IAQ and sleep"* it was shown that CO2 concentrations frequently reach 5000ppm indicating poor ventilation (Wargocki, 2019). One study investigated the effects of PM2.5 and temperature on sleep (Liao, Delghust, & Laverge, 2019). Higher PM2.5 concentration was associated with more time awake, while higher ambient temperature was associated with an increased number of awakenings.

Another study looked at sleep quality using low cost monitors (Wargocki, 2019). No relationships between door position (open-closed) and sleep stages were found, but it did change the overall quality significantly. The CO2 concentration around sleeping babies (<1 year old) was also investigated and it was found that measuring CO2 in a baby's bedroom is not enough because it can be up to 40% higher immediately adjacent to the child (Braun & Zeiler, 2019).

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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