
# Summary of the "Ventilative Cooling & HVAC" 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 "Ventilative cooling & HVAC" track at the AIVC 2019 conference consisted of 30 presentations organised in 7 sessions, 5 of which were topical sessions with a number of invited presentations:

1. EBC Annex 80- Resilient Cooling
2. Better implementation of ventilative cooling in national building standards, legislation and compliance tools
3. Model based control and concepts for ventilation systems
4. Measurement and commissioning of ventilation systems and ductwork
5. IEA EBC Annex 79: What information do we need for occupant-centric building design and operation?
6. When the EPR hits the fan, or…the killing of the fan energy
7. Optimized HVAC design and operation

The article available here presents main trends, ideas, considerations and conclusions that emerged from the two days of the conference on this topic.

The topical session “EBC Annex 80- Resilient Cooling” presented the scope and work programme of the IEA EBC annex 80 “Resilient Cooling”. Peter Holzer, the operating agent of annex 80 defined resilient cooling as*: “Resilient cooling is used to denote low energy and low carbon cooling solutions that strengthen the ability of individuals, and our community as a whole to withstand, and also prevent, the thermal and other impacts of changes in global and local climates, particularly with respect to increasing ambient temperatures and the increasing frequency and severity of heat waves”* (Holzer, 2019) (Holzer, 2019). According to this definition, resilient cooling includes technologies and solutions that: reduce externally induced heat gains to indoor environments; offer personal comfort apart from space cooling; remove heat from indoor environments; and control the humidity of indoor environments (Holzer, 2019). Important requirements of resilient cooling are: Reliability & Failure Safety; Affordability & Accessibility; Energy Efficiency & Carbon Neutrality; Social Inclusiveness (Holzer, 2019).

The topical session "Better implementation of ventilative cooling in national building standards, legislation and compliance tools" aimed to provide an insight and discuss how well "Ventilative cooling" currently is currently integrated and used in EN, ISO and national standards, as well as in national legislation and compliance tools (Plesner, Roth, & Heiselberg, 2019). (Plesner & Roth, 2019) presented recently launched technical documents relevant to ventilative cooling systems focusing on thermal comfort in technical committees of CEN ("Ventilative cooling systems” - WG/21 in CEN/TC 156) and ISO ("Design process of natural ventilation for reducing cooling demand in non-residential buildings”- WG/2 in ISO/TC 205). The initiated projects are foreseen to be released as CEN European Technical Specifications and as an EN standard, with the aim of being released around year 2022-2023 and of course support but not overlap the content of the EPBD standards. (Jones, 2019), (Breesch, 2019), (Flourentzou, 2019) and (Heiselberg, 2019) discussed national standards, legislation and compliance tools in the United Kingdom, Belgium, Switzerland and Denmark. According to (Heiselberg, 2019), the potential application of ventilative cooling is very differently included in standards, legislation and compliance tools across the evaluated countries. Moreover, the speaker stressed the strong need for design guidelines and the further education of engineers and architects to ensure understanding of the phenomena and correct implementation of ventilative (and other forms of passive and natural) cooling, among others.

The use of simulation models in control and development of ventilation products and concepts, was the focus of the topical session “Model based control and concepts for ventilation systems”. (Merema, Saelens, & Breesch, 2019) studied the framework of a model predictive control (MPC) for an all-air ventilation system in an educational nZEB building. Their study showed that with a minimal dataset of indoor, supply and outdoor temperature, solar radiation, airflow rate and occupancy, an MPC could be developed with respect to both thermal comfort and energy efficiency. The airflow rate was decreased by 47% compared to the rule based control in the measurements while the heating energy for ventilation (Qvent) was decreased by 56% for the complete period of four weeks during the transition season (Figure 1).

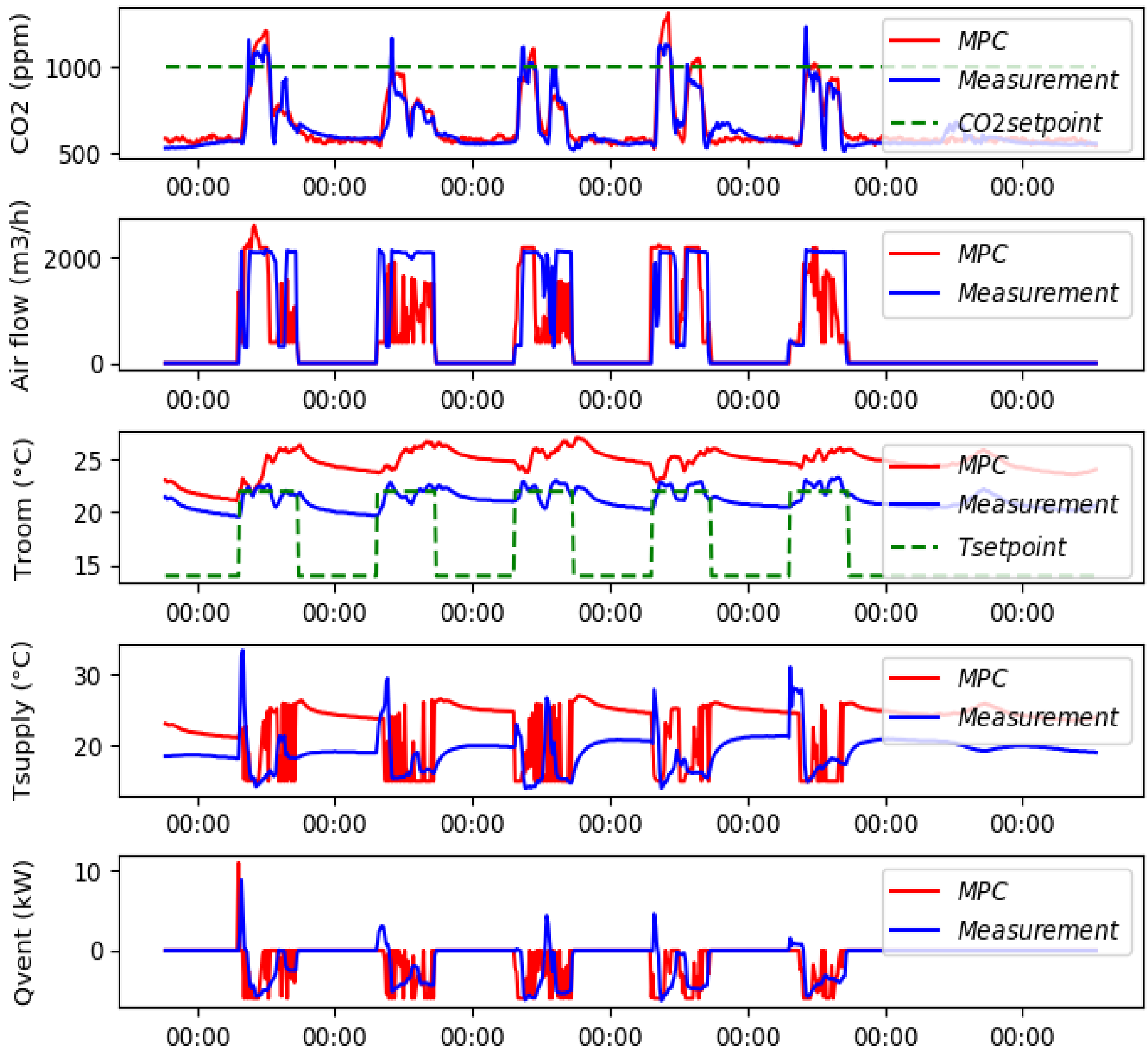


*Figure 1: Results for the ventilation MPC compared to the measurements (Merema, Saelens, & Breesch, 2019)*

The session concluded with a discussion with the audience on the potential & barriers regarding the implementation of MPC in ventilation control. When people were asked whether they think that MPC has potential in control of ventilation systems, the answer was “Yes, a little bit”. Furthermore, identified barriers included: cost; “unclear” potential; lack of knowledge of designers; lack of experience of installers; and the difficulty to convince building owners/users (Breesch & Sourbron, 2019).

The importance of commissioning was assessed during the session “Measurement and commissioning of ventilation systems and ductwork”. (De Strycker, Van Gelder, Andrzejewicz, & Leprince, 2019) described the Flemish quality framework for the inspection of residential ventilation systems launched in the beginning of 2016. They discussed some results of the quality framework (Figure 2) (the effectiveness of the audits, the outcome of the audits on preliminary designs, the challenges in measuring ventilation flows on-site, the energy use of the fans and the conformity of ventilation systems with the regulatory requirements) and found that it is possible to set up an effective and efficient quality framework for inspections on ventilation systems.

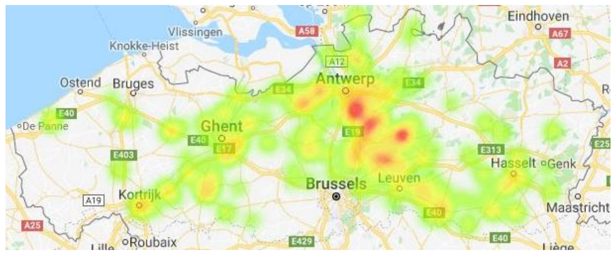


*Figure 2: Audits performed in 2018 (De Strycker, Van Gelder, Andrzejewicz, & Leprince, 2019)*

(Borsboom, Kornaat, van Beek, & Bink, 2019) looked into performance contracts as an important driver for quality management in The Netherlands. The authors stressed that simplified quality management tools should make it possible during the construction process to simply and effectively measure the most important aspects affecting the overall performance of the ventilation system: noise from the ventilation system, volume flow and airtightness of the building envelope.

(Remion, Moujalled, & El Mankibi, 2019), (Berthault & Leprince, 2019), (Paralovo, et al., 2019) and (Few & Elwell, 2019) focused on the development/refinement of test procedures for measuring airflow rates. (Remion, Moujalled, & El Mankibi, 2019) experimentally assessed dynamic analysis methods of decay methods under mechanical variable airflows. (Berthault & Leprince, 2019) investigated the reliability of ductwork airtightness measurements and specifically the impact of pressure drop and leakage repartition on the test result. (Paralovo, et al., 2019) introduced an ongoing project aiming to develop a reliable and reproducible tracer gas test (TGT) using as tracer a substance that is safe for use during occupancy and that can be co-captured and co-analysed with standard passive samplers used for common IAQ assessments. Along this line, (Few & Elwell, 2019) explored the constraints of existing methods when measuring the ventilation rate of occupied buildings and proposed a new method based on metabolic $CO_2$ tracer gas decay which uses an automated algorithm to detect occupancy.

Several presentations (Mahdavi, 2019), (Olesen, 2019), (Belmans, Aerts, Verbeke, Audenaert, & Descamps, 2019) highlighted the importance of the users/occupants. The topical session “IEA EBC Annex 79: What information do we need for occupant-centric building design and operation?” aimed to inform about the activities and first outcomes of the IEA EBC Annex 79, gather information about the needs and expectations of planners with regard to occupant models, and discuss obstacles and possible solutions for implementing advanced occupant behavior/occupancy models in building design and operation tools (Mahdavi, 2019) (Figure 3).

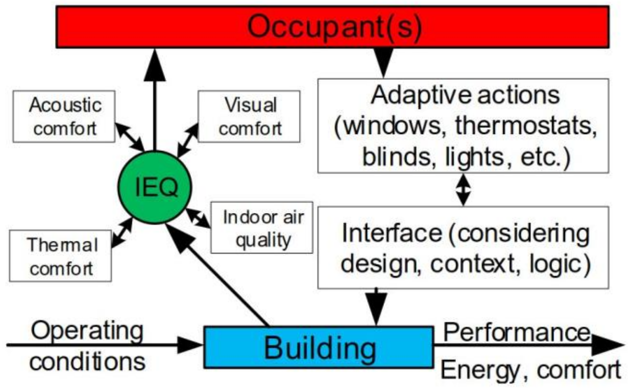


*Figure 3: Advanced modelling of occupant behaviour in buildings assumes that occupants are active decision-making agents who respond to indoor environmental conditions. (Wagner & O'Brien , 2019)*

During the topical session "When the EPR hits the fan, or…the killing of the fan energy", the organizers stressed the need for reduction of the fan energy for ventilation in large non-residential buildings (van der Aa, Heiselberg, & de Gids, 2019). They investigated existing barriers (unfamiliarity and knowledge gap in daily practice and of how to design low-pressure systems, "wish to control" the air flow, the IAQ and the comfort conditions, market hesitation to leave traditional approaches etc.) and aimed to define next steps, related research work and available contributions & interest in the field in order to overcome these barriers and reduce fan energy considerably.

The session "Optimized HVAC design and operation" included contributions from (Sekhar, 2019), (Lastovets, Sirén, Kosonen, Jokisalo, & Kilpeläinen, 2019), (Alzaid, Kolokotroni, & Awbi, 2019) and (Van Gaever, Caillou, & Pecceu, 2019) amongst others. (Sekhar, 2019) tracked the evolution of ventilation strategies in Air-Conditioning and Mechanical Ventilation (ACMV) systems as well as the associated ventilation and IAQ guidelines and standards in Singapore since the 70s. (Lastovets, Sirén, Kosonen, Jokisalo, & Kilpeläinen, 2019) introduced a dynamic temperature gradient model for displacement ventilation (DV) in a lecture hall.

(Alzaid, Kolokotroni, & Awbi, 2019) presented a comparative study based on CFD simulation between the performance of Impinging Jet Ventilation (IJV) and Mixing Ventilation (MV) systems in providing indoor air quality and thermal comfort for a mechanically ventilated occupied large open plan office. The evaluation was carried out using the Air Distribution Index (ADI). They found that the IJV system is more effective than the MV system in removing both pollutants and heat from the occupied zone and concluded that using ADI to assess the effectiveness of different ventilation systems in large enclosures can provide useful information that combines both indoor air quality and thermal comfort.

(Van Gaever, Caillou, & Pecceu, 2019) examined several interventions to minimise the influence of the stack effect and wind on the operation of a classical mechanical exhaust ventilation system as defined by the current Belgian standard NBN D50-001 (1991). Their results showed that ineffective solutions involve increasing the airflow rates of mechanical extraction; balancing the airflow rates per floor level; and using larger transfer openings between the spaces in the dwelling. However, adding a local mechanical component to the classical MEV system and demand control lead to a more effective operation of MEV system.

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