40th AIVC - 8th TightVent & 6th venticool Conference

From energy crisis to sustainable indoor climate - 40 years of AIVC

15-16 October 2019

Het Pand, Ghent University, Belgium

FINAL PROGRAMME

www.aivc2019conference.org

Conference Organizers

AIVC

GHENT UNIVERSITY

TightVent Europe
BUILDING AND DUCTWORK AIRTIGHTNESS PLATFORM

venticool
the international platform for ventilative cooling

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EBC
Energy in Buildings and Communities Programme

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40th AIVC - 8th TightVent & 6th venticool Conference

From energy crisis
to sustainable indoor climate
40 years of AIVC

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General Information

Congress Venue

Het Pand, Ghent University, Onderbergen 1, 9000 Gent

Secretariat Hours

Secretariat will be open during the following dates and times:

Monday October 14th, 2019, 18:30 – 20:00, Castle of the Counts (Gravensteen)

Tuesday October 15th, 2019, 07:30 – 19:00, Het Pand, Ghent University

Wednesday October 16th, 2019, 08:00 – 18:30, Het Pand, Ghent University

Poster display information

- Posters should be set up on **Tuesday October 15th, 2019** from **09:30**
- Dismantling of posters should be finished by **Wednesday October 16th, 2019** at **18:30**

Secretariat and Organizers have no liability for posters left behind

Poster dimensions

(A0) size, 120cm Height X 80cm Width

Poster presentation session

Authors are expected to be in front of their poster in order to reply to any questions as per schedule below:

Tuesday October 15th, 2019 from 19:00 to 21:00

Long & Short Oral Presentations information

- Long Oral Presentations (indicated within the programme) are expected to last 12 minutes; another 3 minutes are foreseen for questions and answers (15 minutes in total).
- Short Oral Presentations (indicated within the programme) are expected to last 3 minutes; another 2 minutes are foreseen for questions and answers (5 minutes in total).

Social Events

Welcome Reception

Monday, October 14th, 2019 / 19:00

Castle of the Counts (Gravensteen)
Sint-Veerleplein 11, 9000, Ghent, Belgium
*(*all registered delegates are welcome to participate)*
https://visit.gent.be/en/see-do/castle-counts

Gala Dinner

Wednesday, October 16th, 2019

Kindly note that admission to the Gala Dinner is not included in the conference registration fees.Tickets are available here:
https://www.aivc.org/40th-aivc

Tuesday October 15th, 2019

ROOM I / REFTER

08:30-10:00 — **Opening - Plenary session**

Chairs: **Peter Wouters, Paula Wahlgren**

Welcome on behalf of Ghent University & Belgian AIVC Board members
Arnold Janssens, *Ghent University, Belgium* & **Samuel Caillou,** *BBRI, Belgium*

Welcome on behalf of AIVC, venticool, TightVent
Peter Wouters, *Manager, INIVE EEIG, Belgium*

History of the AIVC
Peter Wouters, *Operating Agent, AIVC, Belgium*

Building for People & Performance. Achieving Operational Excellence
Darryl K. Boyce *(Invited Speaker), ASHRAE President, USA*

Facing the global overheating through mitigation and adaptation technologies - the role of ventilation
Mattheos Santamouris *(Invited Speaker), UNSW, Australia*

CurieuzeNeuzen: Monitoring air quality together with 20.000 citizens
Sam de Craemer *(Invited Speaker), University of Antwerp, Belgium*

Industry views on the future of ventilation
Yves Lambert *(Invited Speaker), EVIA, Belgium*

10:00-10:30 — Coffee Break

10:30-12:00 — **Session 1A - Topical Session**
(Performance-based assessment methods for ventilation systems)

Chairs: **Gaëlle Guyot, Samuel Caillou**

In most of the current standard and regulations, the design of ventilation system is mainly based on prescriptive approaches. In such prescriptive approaches, the requirements are expressed in the form of minimum flowrates, size of openings, places of supply and exhaust, etc. The prescriptive approaches set the means and not the final goal, possibly limiting then innovation. In the context of energy performance regulations and of new innovative ventilation systems (i.e. Demand Controlled Ventilation or Smart systems), a few performance-based approaches have been developed in some countries for the assessment of these systems on the energy savings. Performance-based assessment methods open the opportunities to evaluate more equitably innovative smart ventilation systems as well as more complex systems (such as natural ventilation) for energy performance calculation but also to assess the ventilation performances on IAQ at the design stage.

This topical session will explain why and what is performance-based assessment methods, present some existing approaches in different countries, and discusses the challenges and perspectives for the future. The objectives of this session are to: provide an overview of the performance-based assessment methods; present current methods in a few countries; and identify challenges of these methods; draw perspectives for the future.

10:30-12:00

Introduction: Why performance-based assessment methods? Overview of the needs and the possibilities
Gaëlle Guyot, *Cerema, France*

Performance-based assessment methods for ventilation systems: Overview of on-going work in France and in Europe
François Parsy, *AERECO, France* **& Gaëlle Guyot,** *Cerema, France*

Performance-based Spanish regulations relating to indoor air quality
Pilar Linares-Alemparte, *Eduardo Torroja Institute for construction sciences-CSIC, Spain*

Challenges and limitations of performance-based approaches: the Belgian experience
Samuel Caillou & Sébastien Pecceu, *BBRI, Belgium*

Demand controlled ventilation: Sensitivity and robustness of the performances
Xavier Faure, *Univ Paris Saclay, France*

Discussion with the audience
Iain Walker, *LBNL, USA*

Conclusions & Perspectives
Samuel Caillou, *BBRI, Belgium*

ROOM II / AUGUST VERMEYLEN

10:30-12:00

Session 1B - Long Oral Presentation Session
(Test methods for building air tightness)

Chairs: **François Rémi Carrié, Adeline Bailly Mélois**

Applicability of a simple and new airtightness measuring method and further comparisons with blower door measurements
Timothy Lanooy, *ACIN instrumenten, The Netherlands*

Refined assessment and comparison of airtightness measurement of indoor chambers using the blower door and Pulse methods
Christopher Wood, *University of Nottingham, United Kingdom*

Evaluation of indoor pressure distributions in a detached house using the Pulse airtightness measurement technique
Yun-Sheng Hsu, *University of Nottingham, United Kingdom*

Insights into the impact of wind on the Pulse airtightness test in a UK dwelling
Yun-Sheng Hsu, *University of Nottingham, United Kingdom*

Estimation of Air Leakage Sizes in Building Envelope using High-Frequency Acoustic Impulse Response Technique
Benedikt Kolsch, *German Aerospace Center (DLR), Germany*

Deviation of blower-door fans over years through the analysis of fan calibration certificates
Valérie Leprince, *PLEIAQ, France*

Tuesday October 15th, 2019

ROOM III / PRIORZAAL

10:30-12:00

Session 1C - Topical session (IEA EBC Annex 79: What information do we need for occupant-centric building design and operation?)

Chairs: **Andreas Wagner, Ardeshir Mahdavi**

Buildings account for approx. 40% of the energy use in industrialized countries. Although various policies (e.g., building codes and incentives) were introduced to improve the quality of building envelopes and HVAC efficiency, very often a performance gap between designed and actually monitored energy consumption of buildings can be observed. Depending on the building type and degree of automation, occupants have a great influence of building energy use. For instance, Hong and Lin (2013) performed a simulation study to show that occupant behaviour at the office scale could increase energy use by 80% or reduce it by 50% from standard assumptions. This topic is exactly in the focus of the new IEA EBC Annex 79, which intends to integrate and implement occupancy and occupant behaviour into the design process and building operation to improve both energy performance and occupant comfort. The main objectives of the Annex are: developing new scientific knowledge about adaptive occupant actions driven by multiple interdependent indoor environmental parameters; understanding interactions between occupants and building systems in view of adaptive opportunities for improving the comfort situation, and regarding building energy use; deploying 'big data' (e.g. data mining and machine learning) for the building sector based on various sources of building and occupant data as well as sensing technologies; developing methods, guidelines, and recommendations for standards that integrate occupant models in building design and operation; and performing focused case studies to test the new methods and models in different design and operation phases in order to obtain valuable feedback for researchers and practitioners. The workshop will briefly introduce different fields of related research followed by a discussion about the needs and expectations of planners with regard to occupant models. In this context we want to gather views, opinions, and experiences regarding the following questions:

- *What information about occupants is necessary for developing occupant-centric building and systems designs? What do planners rely on when they assess building energy performance?*
- *Who has/provides this information about occupants/occupancy in the early design process/for building operation? What is the quality of this information?*
- *Who is responsible to collect and further process this information?*
- *What models are needed to use the available information about occupancy/occupant behaviour in design tools (sizing of components, energy calculation routines, performance simulation)*

The objectives of this session are to: inform about 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 behaviour/occupancy models in building design and operation tools.

Occupant-centric building design and operation – objectives, scope and activities of IEA EBC Annex 79
Andreas Wagner, *Karlsruhe Institute of Technology, Building Science Group, Germany*

10:30-12:00 **Occupant-centric building design and operation – remarks on advanced occupant models and the role of 'big data'**
Ardeshir Mahdavi, *Technical University of Vienna, Austria*

60 min structured discussion on questions outlined under description of session
Workshop participants

12:00-13:30 Lunch Break

ROOM I / REFTER

13:30-14:45 **Session 2C - Topical Session (40 years of AIVC)**

Chairs: **Max Sherman, Willem De Gids**

This session will take a look at the AIVC over the 40 years from its first conference until today. The chairs of this session attended that first conference and have served as long-time members of the AIVC Board of Directors for their respective countries. As the senior statesmen of the AIVC they will oversee a historical review of the AIVC and of the current Tech Note that looks back on key contributions that AIVC has made to the field.

The AIVC of the 20th Century
Martin Liddament, *VEETECH Ltd, United Kingdom*

The AIVC of the 21st Century
Peter Wouters, *INIVE, Belgium*

40 years of Modeling Airflows
Iain Walker, *LBNL, USA*

The Role of Carbon Dioxide in Ventilation and IAQ Evaluation: 40 years of AIVC
Andy Persily, *NIST, USA*

ROOM II / AUGUST VERMEYLEN

13:30-14:45 **Session 2A - Topical Session**
(Ventilation design and control in residences - current challenges, innovative solutions and case studies gathered by IEA-EBC Annex 68)

Chairs: **Esfand Burman, Carsten Rode**

This session will provide a summary of the activities carried out as part of Subtask 4 of the IEA-EBC Annex 68 project. This research project is focused on Indoor Air Quality Design and Control in Low Energy Residential Buildings. Subtask 4 of this project aims to devise optimal and practical design and control strategies for high indoor air quality in residential buildings. These strategies are informed by a review of the state of the art and synthesis of research undertaken in other subtasks of the project. An overview of the current practices and challenges facing the industry in procurement of ventilation systems in low-energy dwellings will be presented based on the outcomes of a stakeholder survey in seven European countries. This will be followed by a brief introduction of the report developed for this subtask. The report contains several case studies that identify current challenges and innovative solutions in various contexts. Five short presentations by participants in IEA-EBC Annex 68 will provide a synopsis of the research undertaken and body of knowledge collated in this project. Each presentation will be followed by a brief Q&A session with a more general discussion about IEA-EBC Annex 68 and its key outcomes in the end.

Introduction: How IEA EBC Annex 68 identified challenges and potential solutions in design and control of ventilation system in residences
Esfand Burman, *UCL, United Kingdom* **& Carsten Rode,** *DTU, Denmark*

Tuesday October 15th, 2019

13:30-14:45

HVAC and VOCs: interaction between building systems and indoor VOC concentrations
Klaas De Jonge, *Ghent University, Belgium*

Alternative ducting options for balanced mechanical ventilation systems in multifamily housing
Gabriel Rojas, *University of Innsbruck, Austria*

Lessons learned from a ten-year monitoring in residential buildings equipped with humidity-based demand controlled ventilation in France
Gaëlle Guyot, *Cerema, France*

Practical use of the Annex 68 IAQ Dashboard
Marc Abadie, *University of La Rochelle, France*

Lessons learned from design and operation of ventilation systems in low-energy dwellings in the UK
Esfand Burman, *UCL, United Kingdom*

ROOM I / REFTER

15:00-16:30

Session 3A - Topical Session (Controlling moisture for improved IAQ)

Chairs: **Arnold Janssens, Paula Wahlgren**

Moisture in the air is one of the reasons for ventilating a building, as is removing contaminants and odours. Since there are major health issues related to high moisture levels in buildings, moisture is an important aspect to consider. Fungal spores and dust mites proliferate under high levels of moisture and have been identified as aggravating conditions such as allergy, asthma and other bronchial problems. Furthermore, water vapour in contact with cold surfaces leads to high surface humidities or condensation, where it can cause considerable damage through mould growth and fabric decay. In the last 40 years our understanding of the relation between indoor humidity, ventilation, building envelope design and mechanisms for biological decay has increased a lot. Still, new research is going on to better control humidity and microbial growth and associated health issues or damage in buildings.

This session gives an historic overview of the findings on this topic during 40 years AIVC activities, and presents new advances in the field. The objectives of this session are to: create understanding of factors defining indoor air humidity and the consequences of humid indoor environments; and give information on advances in controlling indoor humidity through smart ventilation technology and quality assessment schemes.

Moisture in indoor air: findings of 40 years
Paula Wahlgren, *Chalmers University of Technology, Sweden*

Issues on humidity environment and health problem
Hiroshi Yoshino, *Tohoku University, Japan*

Fungal growth on timber frame houses
Michiel Vanpachtenbeke, *KU Leuven, Belgium*

Big humidity data from smart ventilation systems
Jelle Laverge, *Ghent University, Belgium*

ByggaF - A Method to Include Moisture Safety in the Construction Process
Kristina Mjörnell, *RISE, Sweden*

Analysis of the Effects of Ventilation Method on Indoor Humidity Distribution and Condensation by CFD method
Fangyuan Zhang, *Kitakyushu University, Japan*

ROOM II / AUGUST VERMEYLEN

15:00-16:30 Session 3B - Long Oral Presentation Session
(Energy performance of ventilation systems)

Chairs: **Samuel Caillou, Andy Persily**

Performance of an Advanced Heat Recovery Ventilation System in the Canadian Arctic
Justin Berquist, *National Research Council, Canada*

Long-term performance and resiliency testing of a dual core energy recovery ventilation system for the Arctic
Boualem Ouazia, *National Research Council, Canada*

Experimental investigation of frost formation on air to air counter flow heat exchanger in air handling unit and climatic influence on dry, wet, frost operation condition
Michal Pomianowski, *Aalborg University, Denmark*

Efficiency of heat recovery ventilation in real conditions: feedback from several measurement campaigns
Sebastien Pecceu, *hBBRI Institute, Belgium*

Impact of ductwork leakage on the fan energy use and sound production of central mechanical ventilation units in houses
Valérie Leprince, *PLEIAQ, France*

The contribution of a solar air heater collector to the cooling load in a building
Pavlos Toumpoulidis, *Democritus University of Thrace, Greece*

ROOM III / PRIORZAAL

15:00-16:35 Session 3C - Long Oral Presentation Session
(Optimized HVAC design and operation)

Chairs: **Martin Liddament, Willem de Gids**

Evolution of ventilation strategies in air-conditioned buildings in Singapore – IAQ and Energy perspectives
Chandra Sekhar *(Invited Speaker), National University of Singapore, Singapore*

Dynamic performance of displacement ventilation in a lecture hall
Natalia Lastovets, *Aalto University, Finland*

Numerical Modelling of Large Air-Conditioned Space: Comparison of Two Ventilation Systems
Maria Kolokotroni, *Brunel University London, United Kingdom*

Proposal of Optimal Control Method in order to reduce Mutual Interference of Air Conditioning Indoor Units
Yuga Urata, *University of Kitakyushu, Japan*

Minimizing the influence of the stack effect and wind on the operation of mechanical exhaust ventilation systems
Samuel Caillou, *BRRI, Belgium*

Multi-Objective Optimization of Energy Saving and Thermal Comfort in Thermo Active Building System based on Model Predictive Control
Yohei Ogawa, *University of Kitakyushu, Japan*

16:30-17:00 Coffee Break

Tuesday October 15th, 2019

ROOM I / REFTER

17:00-18:15 **Session 4A – Short Oral Presentation session**

Chairs: **Wendy Miller, Christophe Delmotte**

Two Case Studies on Ventilation for Indoor Radon Control
Justin Berquist, *National Research Council, Canada*

Influence of ventilation on radon concentration in a study case in Spain
Pilar Linares-Alemparte, *Eduardo Torroja Institute for construction sciences-CSIC, Spain*

Energy and Indoor Air Quality Analysis of Mixed Air and Displacement Ventilation Systems
Walid Chakroun, *Kuwait University, Kuwait*

Investigation of The Combined Effect of Indoor Air Stability and Displacement Ventilation on Pollutant Transport in Human Breathing Microenvironment
Xiaorui Deng, *Hunan University, United Kingdom*

Indoor environment and adverse health symptoms among children under home damp conditions
Kenichi Hasegawa, *Akita Prefectural University, Japan*

Relationship between indoor allergen and occupants' allergic symptoms before and after moving in the house with the countermeasure against allergy
Teruaki Mitamura, *Maebashi Institute of Technology, Japan*

Learning Performance in Odor Environment with aroma oils: Influence of Odor of Essential Oils on Learning Performance in Classroom
Aya Eto, *Osaka University, Japan*

A large-scale longitudinal indoor air quality study: is low-cost sensor deployment a viable approach?
James McGrath, *National University of Ireland, Galway, Ireland*

An argument for a reality check in the ventilation industry: We still have an energy crisis, in practice, and are not generally, in practice, achieving better indoor climate
Sergio Fox, *AWE, Denmark*

Status of Air filter energy performance and product characteristics
Kiyan Vadoudi, *Eurovent Certita Certification, France*

Influence of Building Envelope's Solar Reflectivity, Wind Speed and Building Coverage Ratio on Urban Heat Environment
Haruto Kitakaze, *Osaka University, Japan*

The influence of external environment characteristics on the heating and cooling load of super-tall residential building
Hygeong-Tae Kim, *Seoul National University, Korea*

Improvement Method of Thermal Environmental Near Windows During Heating Period -Thermal and Air Flow Characteristics of Two-Dimensional Jet from Breeze Line Diffuser in Free Field
Shaoyu Sheng, *Osaka University, Japan*

ROOM II / AUGUST VERMEYLEN

17:00-18:15

Session 4B - Short Oral Presentation session

Chairs: **Hiroshi Yoshino, Adeline Bailly Mélois**

Airtightness and energy impact of air infiltration in residential buildings in Spain
Irene Poza-Casado, *Universidad de Valladolid, Spain*

Exist'air: airtightness measurement campaign and ventilation evaluation in 117 pre-2005 French dwellings
Sylvain Berthault, *Cerema, France*

New findings on measurements of very airtight buildings and apartments
Stefanie Rolfsmeier, *BlowerDoor GmbH, Germany*

Comparison between infiltration rate predictions using the divide-by-20 rule of thumb and real measurements
Alan Vega Pasos, *The University of Nottingham, United Kingdom*

On the experimental validation of the infiltration model DOMVENT3D
Alan Vega Pasos, *The University of Nottingham, United Kingdom*

How Accurate is our Leakage Extrapolation? Modeling Building Leakage Using the Darcy-Weisbach Equation
Steven Rogers, *The Energy Conservatory, USA*

Vertical Distribution of Temperature and Contaminant Concentration in a Room with Impinging Jet Ventilation System
Mako Matsuzaki, *Osaka University, Japan*

Analysis of convective heat transfer coefficient correlations for ventilative cooling based on reduced-scale measurements
Twan Van Hoof, *KU Leuven, Belgium*

Overheating reduction in a house with balanced ventilation and postcooling
Bart Cremers, *Zehnder Group, The Netherlands*

Modelling thermal comfort and energy consumption of a typical mixed-cooling apartment in Guilin, China
Jie Han, *Guilin University of Electronic Technology, China*

Comfort at Hospital Reception Desks
Regina Bokel, *Delft University of Technology, The Netherlands*

Prediction of the influence of solar radiation on adaptive thermal comfort using CFD simulation
Juti Hu, *Hunan University, China*

Tuesday October 15th, 2019

ROOM III / PRIORZAAL

17:00-18:15 **Session 4C - Short Oral Presentation session**

Chairs: **Maria Kolokotroni, Hilde Breesch**

Developing a new passive tracer gas test for air change rate measurement
Sarah Paralovo, *University of Ghent, Belgium*

Measuring the ventilation rate in occupied buildings and adapting the CO2 tracer gas technique
Jessica Few, *University College London, United Kingdom*

Airtightness and non-uniformity of ventilation rates in a naturally ventilated building with trickle vents
Jessica Few, *University College London, United Kingdom*

Effects of Outdoor Environment on Air Exchange Rate
Maria Marrero, *University of Coimbra, Portugal*

Successive Indoor Air Pressure Calculation Method for Natural Ventilation Rate Prediction
Haruna Yamasawa, *Osaka University, Japan*

Using CFD simulation to improve estimation of wind pressure coefficient for naturally ventilated buildings in tropical climate
Matthieu Zubialde-Elzaurdia, *University of French Polynesia, French Polynesia*

Experimental study of the combination of a positive input ventilation and active air vents on the air change rates of a house
Antoine Leconte, *CEA, France*

An investigation of ventilation control strategies for louver windows in different climate zones
Leonie Scheuring, *Technische Universität Dresden, Germany*

Cooling Performance of Air-Conditioning System with Ceiling Suspended Packaged Air Conditioning Unit over Divided-Type Membrane Ceilings in Large Classroom
Ito Shogo, *Osaka University, Japan*

Modelling of Supply Air Jet from Diffusers of Four-way packaged Air-conditioner for CFD Analysis on Unsteady Airflow in Room
Norikazu Yasuda, *Osaka University, Japan*

Multi-objective design of single room ventilation units with heat and water recovery
Vincent Lemort, *University of Liege, Belgium*

Review of building services solution fitted for a low emission building stock in urban areas
Matthias Haase, *SINTEF, Norway*

Comparative life-cycle assessment of constant air volume, variable air volume and active climate beam systems for a Swedish office building
Nadeen Hassan, *Lund University, Sweden*

Tuesday October 15th, 2019

ROOM I / REFTER

18:15-18:45	**Indoor Environmental Quality – Global Alliance (IEQ-GA) official launch** *Chairs:* **Anita Derjanecz,** *REHVA Managing Director* **Welcome speech** **Donald Weekes,** *IEQ-GA President* **Presentation of IEQ-GA founding members and their industries:** • **Atze Boerstra,** *REHVA Vice President* • **Peter Wouters,** *Manager of INIVE/AIVC* • **Darry K Boyce,** *ASHRAE President* • **Bjarne W. Olesen,** *ASHRAE Past President 2017/18* • **Vishal Kapur,** *Presidential Member of ISHRAE* • **Luca Alberto Pitera,** *Secretary General of AiCARR* **Official delivery of incorporation certificate to IEQ-GA founding members**
18:45-19:00	**90 seconds industry presentations** *Chairs:* **François Rémi Carrié** *Presentations by:* **Acin, Blowerdoor, Efficiency Matrix, Eurima, Lindab, Renson, Retrotec, Soudal**
19:00-21:00	**Poster presentations – Industry stands – Cocktail reception with snacks**

Wednesday October 16th, 2019

ROOM I / REFTER

08:30-09:45 Session 5A - Long Oral Presentation Session (IEQ field studies)

Chairs: **Pilar Linares-Alemparte, Shamila Haddad**

Enhancing thermal comfort and indoor air quality in Australian school classrooms
Shamila Haddad, *UNSW, Australia*

Indoor air and environmental quality in social housing dwellings in Australia
Mattheos Santamouris, *UNSW, Australia*

Radiant heating and cooling systems combined with displacement ventilation in schools; strategies to improve IAQ
Michel Tardif, *Natural Resources Canada, Canada*

The evaluation of real-time indoor environment parameters measured in 297 Chilean dwellings
Benjamin Jones, *University of Nottingham, United Kingdom*

Ventilation and Measured IAQ in new US homes
Iain Walker, *LBNL, United States of America*

ROOM II / AUGUST VERMEYLEN

08:30-10:00 Session 5C - Topical Session (Model based control and concepts for ventilation systems)

Chairs: **Hilde Breesch, Maarten Sourbron**

Simulation models are nowadays an essential part of design, control and commissioning of HVAC systems. Product developers, engineers in engineering offices as well as researchers use building energy simulation (BES) models, ventilation airflow models, system simulation models, CFD, etc. This topical session focusses on the use of simulation models in (1) control and (2) development of ventilation products and concepts. First, a model based predictive control (MPC) takes into account the current situation and the future demand, enabling a more robust control of the ventilation system. The operation of an MPC is contrary to a standard rule-based control strategy that is reactive and causes the system 'lags behind' in relation to the demand. Reliable, model-based prediction of occupancy and weather forecast for ambient temperature and solar radiation are needed for future control actions of the supply air flow rate and temperature. MPC already has shown an energy saving potential in real cases for buildings with hydraulic thermal energy systems. The question arises what the potential is of a model based predictive control in ventilation and all-air systems. On the one hand, all-air systems are fast responding systems compared to systems with thermal energy storage. On the other hand, MPC could be interesting for heating and cooling by ventilation if the interaction between the air and the thermal mass of the building is considered.

Second, model-based product development ensures to offer the optimum total package of ventilation, solar protection, heating and cooling. Every application is very different and case specific because of user behaviour and configuration possibilities of the used techniques. As a result, model-based approach of product development and quotation is necessary.

08:30-10:00

The objective of this session is to open the discussion about the use of (simulation) models in ventilation control and concepts: What are opportunities, challenges, benefits and difficulties of model based (predictive) control for ventilation and all-air systems? How can simulation models improve the development of new ventilation concepts and products?

Overview of model-based control strategies for ventilation systems
Hilde Breesch, *KU Leuven, Belgium*

Predictive control for an all-air ventilation system in an educational nZEB building
Bart Merema, *KU Leuven, Belgium*

Model based design of intelligent ventilation concepts
Koen Maertens, *Duco Ventilation & Sun Control, Belgium*

A case study on residential mixed-mode ventilation using the Ventilation Controls Virtual Test Bed
Bert Belmans, *Vrije Universiteit Brussel, Belgium*

Discussion with the audience

ROOM III / PRIORZAAL

08:30-10:00

Session 5B - Topical Session (Integrating uncertainties due to wind and stack effect in declared airtightness results)

Chairs: **Valérie Leprince, Dimitrios Kraniotis**

Building airtightness tests have become very common in several countries, either to comply with minimum requirements of regulations or programmes, or to justify input values in calculation methods. This raises increasing concerns for the reliability of those tests. There are four key sources of uncertainty in airtightness testing: 1) Measurement devices (accuracy and precision); 2) Calculation assumptions (e.g. reference pressure, regression analysis method); 3) External conditions (wind and stack effect impact); and 4) Tester's behaviour. While competent tester schemes and independent checking procedures show potential to contain errors due to the tester's behaviour, there have been extensive yet sterile debates about how the building pressurisation test standard ISO 9972 should address other sources of uncertainties. As a result, no change has been made on these aspects on the new version of the standard which was published in September 2015. With the present standard, the zero-flow pressure shall not exceed 5 Pa for the test to be valid. Consequently, in moderately windy conditions, it may be impossible to perform a pressurisation test in accordance with the standard, even using precautions with a careful uncertainty analysis.

This is the third topical session on this subject. The objectives of this new session are to: better understand and improve the pressure measurement on site; estimate the impact of wind through CFD modelling and model-scale measurement.

Influence of the external pressure tap position on the airtightness test result
Jiří Novák, *Czech Technical University, Czech Republic*

Wednesday October 16th, 2019

08:30-10:00

Airtightness of buildings – Considerations regarding place and nature of pressure taps
Christophe Delmotte, *CSTC-WTCB, Belgium*

Quantification of uncertainty in zero-flow pressure approximation
Martin Prignon, *Université catholique de Louvain, Belgium*

Designing a model-scale experiment to evaluate the impact of steady wind on building air leakage measurements
Adeline Bailly Mélois, *Cerema, France*

CFD modelling of fan pressurization method in buildings – The impact of dynamic wind on airtightness tests
Dimitrios Kraniotis, *Oslo Metropolitan University, Norway*

10:00-10:30 Coffee Break

ROOM I / REFTER

10:30-11:30 Session 6A - Long Oral Presentation Session (Smart ventilation performance)

Chairs: **François Durier, Benjamin Jones**

Using co-simulation between EnergyPlus and CONTAM to develop IAQ and energy-centric demand-controlled ventilation systems
Maria Justo Alonso, *NTNU, Norway*

Performances of a demand-controlled mechanical supply ventilation system under real conditions: indoor air quality and power distribution for thermal comfort
Clement Laffeter, *Ventilairsec, France*

Large-scale performance analysis of a smart residential MEV system based on cloud data
Ivan Pollet, *Renson Ventilation, Belgium*

Individualised Dynamic Model-Based Monitoring of Occupant's Thermal Comfort for Adaptive HVAC Controlling
Ali Youssef, *KU Leuven, Belgium*

ROOM II / AUGUST VERMEYLEN

10:30-11:30 Session 6C - Topical Session (EBC Annex 80- Resilient Cooling)

Chairs: **Peter Holzer, Chen Zhang**

The world is facing a rapid increase of air conditioning of buildings. It is driven by multiple factors, such as urbanisation and densification, climate change and elevated comfort expectations together with economic growth in hot and densely populated climate regions of the world. Given this mega-trend, it is mandatory to guide this development towards sustainable solutions. The development of cooling solutions has to be guided towards:

- *Energy efficiency and carbon neutrality;*
- *Social inclusiveness, affordability and accessibility;*
- *Reliability and failure safety;*

10:30-11:30

- *Resilience, understood as a cooling system's qualities of toughness, elasticity or adaptability against happenings such as: climate change, weather extremes, changes of physical outdoor conditions; grid blackouts and other breakdowns in supply chains; changes in economic and social conditions*

To support the cooling-development towards these qualities of sustainability and resilience is the target of the new IEA-EBC Annex 80. The topical session will present its scope and work programme, as well as exemplary resilient cooling technologies.

Introduction to Annex 80
Peter Holzer, *IBR&I, Austria*

Outlook on Resilient Cooling Technologies
Bjarne Olesen, *ICIEE.DTU, Denmark*

Experience with Resilient Cooling Technologies in Australia.
Wendy Miller, *QUT, Australia*

Resilience-Indicators of Cooling Technologies.
Shady Attia, *University of Liege, Belgium*

ROOM III / PRIORZAAL

10:30-11:15

Session 6B - Long Oral Presentation Session (Durability of building airtightness)

Chairs: **Valérie Leprince, Arnold Janssens**

Assessment of long-term and mid-term building airtightness durability: field study of 61 French low energy single-family dwellings
Bassam Moujalled, *CEREMA, France*

Assessment of the durability of airtightness products in laboratory controlled conditions: development and presentation of the experimental protocol
Andres Litvak, *CEREMA, France*

Moisture impact on dimensional changes and air leakage in wooden buildings
Paula Wahlgren, *Chalmers University of Technology, Sweden*

ROOM I / REFTER

11:45-12:45

Session 7A - Topical Session (Bedroom ventilation, IAQ and sleep)

Chairs: **Jelle Laverge, Arnold Janssens**

In this session, we would like to give an overview of the state of the art related to IAQ in bedrooms, bedroom ventilation and sleep quality and engage the audience to list research priorities in this area for the near future.

The bedroom is the most intensively used room in the dwelling (both in terms of occupancy density and total time spent) but is unfortunately heavily understudied in ventilation and IAQ sciences. By pooling presentations on this topic into a single session, we hope to increase the visibility of this area of research. Additionally, we feel it is important to link the different sub-fields (ventilation, IAQ and sleep quality) that are looking into the topic together, to stimulate a holistic approach to the challenges in this area.

The objectives of this session are to: provide an overview of the state of the art; support interdisciplinary initiatives; list challenges; and set a research agenda for the future.

Association between Indoor Air Quality and Sleep Quality
Chenxi Liao, *Ghent University, Belgium*

11:45-12:45 **IAQ in Belgian bedrooms**
Marianne Stranger, *VITO, Belgium*
Measurements of sleep quality with low-cost sleep monitors: Effect of bedroom air quality and sleep quality
Pawel Wargocki, *DTU, Denmark*
CO_2-concentration of the surrounding air of sleeping infants inside a crib
Wim Zeiler, *TU Eindhoven, The Netherlands*

ROOM II / AUGUST VERMEYLEN

11:45-12:45 **Session 7C - Long Oral Presentation Session (Measurement and commissioning of ventilation systems and ductwork)**

Chairs: **Gaëlle Guyot, Wouter Borsboom**

Quality framework for residential ventilation systems in Flemish Region in Belgium – feedback after three years' experience
Maarten De Strycker, *BCCA, Belgium*
Commission and performance contracting of ventilation systems in practice. Determination, analyses and consequences for practitioners and contractors
Wouter Borsboom, *TNO, The Netherlands*
Test of new analysis methodologies to assess dynamic airflow rate with the tracer gas decay method
Gabriel Remion, *Cerema, France*
Reliability of ductwork airtightness measurement: impact of pressure drop and leakage repartition on the test result
Sylvain Berhault, *Cerema, France*

ROOM III / PRIORZAAL

11:30-12:45 **Session 7B - Long Oral Presentation Session (Modelling of infiltration and ventilation)**

Chairs: **Chandra Sekhar, Maria Kapsalaki**

Techniques to Estimate Commercial Building Infiltration Rates
Andrew Persily, *NIST, USA*
Wind Pressure Coefficient and Wind Velocity around Buildings in High Density Block of Metropolis for Natural Ventilation Design
Toshio Yamanaka, *Osaka University, Japan*
Alternative solution proposal to improve the air change in light shafts based on flaps
Miguel Angel Padilla-Marcos, *Universidad de Valladolid, Spain*
Probabilistic modelling of wind induced air exchange in buildings
Krystyna Pietrzyk, *Chalmers University of Technology, Sweden*
Impact of an occupancy and activity based window use model on the prediction of the residential energy use and thermal comfort
Silke Verbruggen, *Ghent University, Belgium*

12:45-13:45 Lunch Break

ROOM I / REFTER

13:45-14:45 **Session 8A - Long Oral Presentation Session (Reducing exposure to outdoor pollutants)**

Chairs: **Max Sherman, Manfred Plagmann**

Ambient air filter efficiency in airtight, highly energy efficient dwellings – A simulation study to evaluate benefits and associated energy costs
Gabriel Rojas, *University of Innsbruck, Austria*

Out2In: impact of filtration and air purification on the penetration of outdoor air pollutants into the indoor environment by ventilation
Joris Van Herreweghe, *BBRI, Belgium*

Future trends in laboratory methods to predict HVAC in service filter performance
Paolo Tronville, *Politecnico di Torino, Italy*

A study of the influence of the position of a chimney terminal on the vertical walls of a building on the air quality of the ventilation air supply
Xavier Kuborn, *BBRI, Belgium*

ROOM II / AUGUST VERMEYLEN

13:45-14:45 **Session 8B - Topical Session (When the EPR hits the fan, or…the killing of the fan energy)**

Chairs: **Per Heiselberg, Ad van der Aa**

The last decades big steps have been made on the road to develop and design energy neutral buildings. Despite the large list of developments and improvements of all kind of energy saving technologies we see specifically for the larger non-residential buildings that the electric energy use for fans hardly show any reduction and becomes a dominant factor in the total energy use of these buildings. The fan energy currently counts already for approximately 15-20% of the total building related energy and becomes increasingly important.

Among other developments, the work of IEA Annex 35 "Hybrid ventilation in new and retrofitted office buildings" revealed new directions in the design of ventilation systems. However, in daily practice the HVAC designers and installers do not seriously pick up the (new) knowledge and keep up going the well-known traditional way: designing and realizing mechanical ventilation systems with a total pressure drop of over 800 Pa. The reason not to do so, does not only lie in financial arguments, but is based in a much broader range of barriers. Of course, the unfamiliarity and knowledge gap of how to design low-pressure systems is a relevant stumbling block, but also the "wish to control" the air flow, the IAQ and the comfort conditions results in installations that are fully equipped. All kind of provisions are foreseen that filter, heat, cool, humidify and control the air. And this ends up in the well-known high-pressure system, that needs to be equipped with big fans to get the air on the right place. To come to a serious reduction in fan energy for ventilation the above described circle must be broken.

The objective of this session is to present some views on why the outcomes of these activities are not more widely used today as basis for a discussion on the workshop

13:45-14:45 *on what can be done in the future to overcome the barriers and reduce fan energy considerably. The session will be closed with a discussion where the following topics will be addressed: What steps must be undertaken to come to a reduction of fan energy? What research work must be done? What interest/contribution is available to solve to the topic discussed?*

History and background in the development of low pressure ventilation systems
Per Heiselberg, *Aalborg University, Denmark*

Low pressure systems design examples and practical barriers
Ad van der Aa, *ABT, The Netherlands*

Options for improvement and future research topics on low pressure ventilation systems
Willem de Gids, *VentGuide, The Netherlands*

ROOM III / PRIORZAAL

13:45-14:45 **Session 8C - Topical Session (EBC Annex 78 - Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications)**

Chairs: **Bjarne W. Olesen, Pawel Wargocki**

Worldwide, there is an increasing number of publications related to air cleaning and there is an increasing sale of gas phase air cleaning products. This puts a demand for verifying the influence of using air cleaning on indoor air quality, comfort, well-being and health. It is thus important to learn whether air cleaning can supplement ventilation with respect to improving air quality i.e. whether it can partly substitute the ventilation rates required by standards. There is also a need to evaluate the energy impact of using air cleaning as supplement to ventilation.

In many locations in the world, the outdoor air quality is so bad that it is better to avoid supplying outdoor air to the buildings. In such cases, the alternative to use ventilation is to substitute supply of outdoor air with air cleaning. Even when outdoor air is of a good quality, the use of air cleaning substituting ventilation air could reduce the rate of outdoor air supplied indoors. Therefore, it is possible to save energy for pre heating/cooling the ventilation air and for transporting the air (fan energy). To verify the performance of gas phase air cleaning technologies there is a need to develop appropriate standard test methods.

This is some of the issues that is part of a new IEA-EBC Annex 78, and which will be covered by presentations and discussion in this session. The main objective of this workshop is to present and discuss specific tasks related to the new IEA-EBC annex 78. The annex work will include the presentations and discussions during the future work of the annex.

Introduction to Annex 78
Bjarne W. Olesen, *ICIEE.DTU, Denmark*

Existing air cleaning technologies
Alireza Afshari, *Sbi-AAU, Denmark*

Existing standards for testing gas phase air cleaners
Paolo Tronville, *Polito, Ital*

Methods to evaluate gas phase air-cleaning technologies
Pawel Wargocki, *ICIEE.DTU, Denmark*

ROOM I / REFTER

15:00-16:30 Session 9A - Long Oral Presentation Session (IEQ-metrics and evaluation)

Chairs: **Donald Weekes, Wendy Miller**

Development of Subjective Evaluation Tool of Work Environment for Office Workers' Work Performance and Health Promotion
Yuko Abe, *University of Kitakyushu, Japan*

Evaluation potential of indoor environments' ecological valency
Ardeshir Mahdavi, *TU Wien, Austria*

Residential Application of an Indoor Carbon Dioxide Metric
Andrew Persily, *NIST, USA*

Trade-offs between ventilation rates and formaldehyde concentrations in new-build dwellings in the UK
Esfand Burmam, *UCL, United Kingdom*

Modeling Dynamic Behavior of Volatile Organic Compounds in a Zero Energy Building
Klaas De Jonge, *Ghent University, Belgium*

Indoor air quality in Nearly Zero Energy Buildings, reduction of exposure
Wouter Borsboom, *TNO, The Netherlands*

ROOM II / AUGUST VERMEYLEN

15:00-16:30 Session 9B - Topical Session (EPBD 2018/844/EU Article 19a feasibility study on the "inspection of stand-alone ventilation systems")

Chairs: **Peter Wouters, François Durier**

Article 19a of the Energy Performance of Buildings Directive (EPBD) introduces the requirement for the European Commission to perform a feasibility study addressing two issues: 1)the possible introduction of EU provisions on the inspection of stand-alone ventilation systems and 2)the possible introduction of EU provisions on an optional building renovation passport. DG ENER from the European Commission awarded the contract (December 2018 – December 2019) to perform a technical study to a consortium led by INIVE and BPIE (www.epbd19a.eu).

The session will share outcomes of the study, the outcome of the online survey, as well as related field analyses, to give an overview of the state of the art regarding regulations, standards and guidelines available in the EU and beyond, as well as the stock of ventilation systems and their performances. Existing approaches and those currently under development will be presented and we will discuss the feasibility and expected impact of potential relevant measures at EU level.

Overall introduction on the EPBD article 19a with specific attention on inspection of stand-alone ventilation systems (www.epbd19a.eu)

Overview of existing experiences with relevance to the inspection of stand-alone ventilation systems

Description of the scenarios analysed in the context of the feasibility study

Preliminary results

Interactive voting

Wednesday October 16th, 2019

ROOM III / PRIORZAAL

15:00-16:30 **Session 9C - Topical Session (Better implementation of ventilative cooling (cooling of buildings using outside air as main source) in national building standards, legislation and compliance tools)**

Chairs: **Christoffer Plesner, Jannick K. Roth**

This session will discuss the national and international use of Ventilative cooling (cooling of buildings using outside air as main source either by mechanical or natural means or a combination) in national building standards, legislation and compliance tools. There will be presentations based on national inputs for the status and recommendations to better implementation of Ventilative cooling from 4 countries.

The session ends with an open discussion, asking if the participants feel inspired to use the input and recommendations given during the workshop to be used in their country or for new and upcoming technical documents. Questions to think about prior to joining the workshop: Do you see a clear potential of including ventilative cooling in your national building legislation/guideline? Is new work/research (in your country) needed to reach a better implementation of ventilative cooling? Are there some national barriers for implementation of Ventilative cooling? How is the air flow rate determined for ventilative cooling in your national building legislation/guideline?

The objective of the session is to give the participants an insight into how "Ventilative cooling" currently is integrated into EN, ISO and national standards, as well as in national legislation and compliance tools - with input given by national experts. Finally, the participants will join the discussion on how to improve the implementation of ventilative cooling seen from their perspective.

Introduction
Christoffer Plesner, *Velux, Denmark* **& Jannick Roth,** *WindowMaster, Denmark*

Standardisation projects in CEN and ISO relevant to ventilative cooling systems
Christoffer Plesner, *Velux, Denmark* **& Jannick Roth,** *WindowMaster, Denmark*

Status and recommendations for better implementation of ventilative cooling in UK technical documents
Benjamin Jones, *University of Nottingham, United Kingdom*

Status and recommendations for better implementation of ventilative cooling in Belgium (Flanders)
Hilde Breesch, *Ku Leuven, Belgium*

Status and recommendations for better implementation of ventilative cooling in Switzerland
Flourentzos Flourentzou, *ESTIA SA, Switzerland*

Status and recommendations for better implementation of ventilative cooling in Denmark
Per Heiselberg, *Aalborg University, Denmark*

Findings and road ahead for better implementation of ventilative cooling
Per Heiselberg, *Aalborg University, Denmark*

Discussion with the audience

16:30-17:00 Coffee Break

Wednesday October 16th, 2019

ROOM I / REFTER

17:00-18:30	**Closing Session** *Chairs:* **Arnold Janssens, Iain Walker** **IAQ and energy performance GHG emission: how to translate to occupiers and landlords** **Frank Hovorka** *(Invited Speaker), REHVA President, France* **Ventilative Cooling– Time for large scale implementation?** **Per Heiselberg** *(Invited Speaker), Aalborg University, Denmark* **Summing up of the 'Smart ventilation, IAQ & Health' track** **Benjamin Jones,** *University of Nottingham, United Kingdom* **Summing up of the 'Airtightness' track** **Paula Wahlgren,** *Chalmers University, Sweden* **Summing up of the 'Ventilative cooling and HVAC' track** **Hilde Breesch,** *KU Leuven, Belgium* **Best paper & poster award** **Max Sherman,** *LBNL, USA* **Announcement of 2020 conference** **Dimitris Charalambopoulos,** *ASHRAE Hellenic Chapter, Greece*
18:30	End of conference

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