# General Conference Overview

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<td>8:30 Registration</td>
<td>9:30 Opening + Awards</td>
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<td>9:30 Poster sessions</td>
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<td>10:30</td>
<td>10:30 Coffee break</td>
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<td>11:00 Side meetings  ISIAQ BOD</td>
<td>11:00 Oral sessions</td>
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<td>Academy meeting</td>
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<td>STC Chair person meeting</td>
<td>14:00 Oral sessions</td>
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<td>19:00 Reception</td>
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<td>Conference party</td>
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8:30 to 14:00: Side meetings

14:00 to 21:00:

21:00 to 23:00: Conference party
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Welcome Message

Welcome message from the President of Indoor Air 2016

Dear IA2016 enthusiasts,

We are pleased to welcome you to the 2016 edition of ISIAQ’s flagship conference, Indoor Air, in Ghent, Belgium.

In this vibrant medieval city in the heart of Europe, a stone’s throw away from Brussels, we are looking forward to a meeting that will bring together the whole indoor air and climate community. A week of networking, exchange of ideas, inspiration and above all the best and latest in indoor air sciences.

With your exceptional contributions we will match the highest standards that were set by the 13 previous editions. A top quality technical program fostering multi-disciplinary collaboration, workshops, interactive poster sessions, short courses and social media discussions will set IA2016 apart as the must see IAQ event in 2016.

You can get the latest updates by following us on twitter through @IA2016 and let us know how you are experiencing this exciting week using #IA2016. Let us know how we can help you.

And now, let’s go and enjoy our bi-annual IAQ family meeting!

With best regards,

Jelle Laverge, Tunga Salthammer & Marianne Stranger
Welcome message from the President of ISIAQ

Greetings to participants of Indoor Air 2016! As President of the International Society of Indoor Air Quality and Climate (ISIAQ), I am looking forward to meeting many of you here in beautiful Ghent. I am especially grateful to the organizers: Jelle Laverge, Marianne Stranger and Tunga Salthammer. They sacrificed much time to create a program that is rich with thought-provoking presentations and workshops. I’m especially looking forward to the new style of poster sessions.

Indoor Air is the first of this conference series to occur on a two year cycle. Each Indoor Air conference helps me re-connect to the science and practice of indoor air quality and energize my creativity. I wish the same for you and for all participants. ISIAQ is a highly multidisciplinary organization that promotes the free exchange of ideas, technical expertise and scientific discovery. I hope to continue our long-standing tradition of providing members opportunities for learning from one another, developing collaborations and enlightening the world about the challenges and advances in improving indoor air quality and climate. How, you may ask, can I get more involved? Consider joining one of the ISIAQ Scientific and Technical Committees, mentor a younger ISIAQ member, or start early and plan your technical submission for next-year’s Healthy Buildings conferences. Your contributions make a difference!

With best regards,

Glenn Morrison
President of ISIAQ
Missouri University of Science and Technology, USA
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Crystalline Sponsors

Flanders
State of the Art

Alfred P. Sloan Foundation

Crisp Sponsors

RENSON® GERSTEL

Creating healthy spaces

GRAYWOLF camfil

Interscience

AIR MODUS

## Organisation

### Core organising committee

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<td>Ghent University, Belgium</td>
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<td>Marianne</td>
<td>Stranger</td>
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<td>Tunga</td>
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### Editorial team

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<td>Hui Zhu</td>
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<td>Yingxin Zhu</td>
<td>Tsinghua University</td>
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T3 - Ventilation/Thermal comfort  
T4 - Health  
T5 - Modelisation  
T6 - Energy/Sustainability/Design  
T7 - Emission  
T8 - Microbiology  
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T10 - Tools*
1.1 Opening + Awards
| 08:30 - 09:30
| UFO main auditorium
Formal opening of the conference by officials from Ghent University, VITO and the Flemish Government followed by the Award ceremony from the ISIAQ Academy of fellows.

The Academy awards include:

1. Lifetime Achievement Award - bestowed on occasion to scholars who have made seminal contributions to the indoor air sciences through their career’s work.

2. Pettenkofer Award - awarded to an individual in recognition of outstanding work in advancing the indoor air sciences.

3. Yaglou Award - acknowledge outstanding work of young promising researchers within the indoor air sciences and to encourage them to continue their career in this field.

4. Best Paper Awards - granted to the top papers published in "Indoor Air" during the previous three years, as judged by the editors and editorial board.

5. Student Awards - established in 2008 and are granted in two categories:
   - Student Achievement Awards are given to students based on their commitment and dedication to the field for any combination of academic, professional, and research achievements.
   - Student Paper Awards are given to students who have published an outstanding paper in the field of indoor air quality during the past year.

Welcome address by the IA2016 president and some practical guidelines for the conference delegates.
1.2 Morning posters
| 09:30-10:30
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Chemical exposure-response relationship between air pollutants and reactive oxygen species in the human respiratory tract

Evaluation of measurement methods to accompany recommendations for indoor air quality guidelines in France

Fifteen years’ experience of indoor air investigations in Belgium

Tombs - a Specific Indoor Environment of Ill Health Impact

New Regulation for the Housing Health and Required Qualifications for the Certified Indoor Environment Specialists in Finland

Housing as a modifier of air contaminant and temperature exposure in Great Britain: A modelling framework

Occupants’ Perceptions and Responses to Energy Use and Indoor Climate from the Newly Occupied Passive Houses in Norway: a Questionnaire Survey

A comparison of different ventilation strategies for dwellings in terms of airflow rates and airflow paths

Daytime and night time VOC concentrations in Finnish schools

Evaluating the Oxidative Potential of Indoor and Outdoor Particles with an EPR Assay

Exploration of low-cost open source sensor technology to monitor the built environment in residential buildings
ID117 IAQ and health effects - B. Fisk

Exposure of the Belgian population to indoor radon: assessment, control and regulatory approach in the framework of the new European Directive

Health risk assessment of inhalation exposure to 2-ethylhexanol, 2,2,4-trimethyl-1,3-pentanediol diisobutyrate, and texanol in indoor environments
168 K. Azuma*, T. Tanaka-Kagawa, H. Jinno

Field Study on the Effects of Cold Indoor Environment on Long-Term Care of the Frail Elderly
204 Y. Hayashi*, T. Ikaga, T. Hoshi, S. Ando

Modelling and analysis on effect of occupants’ health related living indoor environment in China typical regions based on structural equation models
222 B. Chen*, Y. Chen, C. Zeng

Statistical associations between housing quality and health among Finnish households with small children - results from two (repeated) national surveys

Utilizing Air-Liquid Interface exposure system to evaluate the inflammation response of ozone and β-pinene oxidative-stress on human lung epithelial cell
234 C.-Y. Chuang*, P.-C. Wu

Study on health performance evaluation of residential buildings in China
459 B. Chen*, M. Zhou, Y. Chen, C. Zeng, Y. Xu

Formaldehyde exposed to different doses of asthma toxicology effects of biological indicators
589 Y. Zhang*

Current knowledge on the health benefits and risks of indoor air ionization
1167 P. Scheepers*, A. Oerlemans, J. Pang

Indoor Air Quality and its’ Health Impact in Urban Lucknow City Homes- A Case Study
1195 A. Lawrence*
ID99 Thermal sensation and adaptation - S. Urlaub

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439 Y. Son*, C. Yoon Chun

Dynamic Thermal Comfort in Architecture and Urban Areas
Development of Wearable Sensing Devices
460 J. Nakagawa*, S.-i. Tanabe

Experimental investigation of airflow and thermal comfort under mixing ventilation in a full scale model room - comparison of lobed and conventional diffusers
598 P. Bragança, K. Sodjavi, A. Meslem*, L. Serres

Thermal sensation and electroencephalogram (EEG)
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734 L. Schellen*, H. Pallubinsky, B. Kingma, W. van Marken Lichtenbelt

A thermophysiological model of the human hand
864 K. Katic*, R. Li, W. Zeiler

Thermal manikins controlled by human thermoregulation models for indoor environment research
1049 A. Psikuta*, N. Martinez, A. Bogdan, B. Koelblen, S. Annaheim, R. Rossi

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1133 M. Luo*, Y. Zhu
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253 J. Hurraß*, T. Gabrio, C. Herr, M. Raulf, G. Wiesmüller

Possibilities and limitations of health assessment of mould exposures indoors

Toxicity assessment from indoor dust using E. coli-lux
625 E. Suominen*, J. Atosuo, E.-M. Lilius

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658 D. Lark*, R. Shoemaker

E. coli lux test from settled dust as a new method in assessing toxicity in indoor air
785 T. Putus*, J. Atosuo, E. Suominen, E.-M. Lilius, J. Kantele

Assessing the indoor air toxicity from the condensed water
829 J. Atosuo*, E. Suominen, E. Aattela, E.-M. Lilius

Indoor air toxicity assessments using neutrophils
831 E.-M. Lilius*, J. Atosuo, E. Suominen

Observation-Based Metrics for Residential Dampness and Mold: A Review Focused on Practicality and Exposure-Related Associations with Health
963 M. Mendell*, K. Kumagai

A Meta-Analysis on Indoor Bacteria and Chronic Health Outcomes
1039 B. Khamsehi*, J. Siegel
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98 A. Sebastian*, A. Löfvendahl, A. Andersson, J. Moldanova

Deposition process of indoor aerosol particles on individual nanofiber during fibrous filtration
185 R. Cai*, L. Zhang

Determination of the collection efficiency of HVAC filters for nanoparticles ≥5 nm
416 C. Asbach*, W. Mölter-Siemens, A. Maria Todea, A. Schmitz, F. Schmidt

Removal of fine and ultrafine particles from indoor air environments by air purifier
451 H.-L. Chen*, C. Chiau Lin, R.-L. Hwang

Filter Application and Performance Evaluation in Fan-Coil Classrooms for Particle Exposure Reduction from Haze in Singapore
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Acoustic-Agglomeration Enhanced Filtration
462 B. Feng Ng*, M. Pun Wan, J. Wen Xiong, S. Jeevan Elankovan

Investigation of combine processes for atmospheric multi-pollutant removal through the HVAC of an individual house
533 K. Morisseau*, A. Joubert, Y. Andres, L. Le Coq

Tests of Indoor Air Purifiers with New and Aged Filters
561 H. Finger*, C. Asbach, T. Van der Graaf

Experimental study on indoor fine particle concentration control strategies for commercial offices
668 J. Ren, J. Liu*, Y. Hou

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973 S. Wang, M. Waring*
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115  J. McGrath*, M. Byrne

**Impact of Ventilation on IAQ in Residential Retrofits**

365  P. Francisco*, S. Cali, D. Jacobs, W. Rose

**Effect of building renovation on energy use and indoor environment: Comparison of simulations and measurements in six apartment buildings**

654  V. Földváry*, J. Kolarik, G. Bekö, TD. Petráš

**Effects of Energy Retrofits on Indoor Gaseous Pollutant Concentrations in Kaunas, Lithuania**


**Simulation and monitoring results of a compact MVHR and micro-heat pump for minimal disruptive renovation**

726  F. Ochs*, D. Siegle, G. Dermentzis, W. Feist

**Assessment of thermal comfort and CO2 concentrations in multi-family apartment buildings before and after retrofit – Lithuanian case study**

727  L. Seduikyte*, T. Prasauskas, D. Martuzevicius, U. Haverinen-Shaughnessy

**Indoor Carbon Monoxide in Weatherization Homes**

858  P. Francisco*, S. Pigg, D. Cautley, D. Jacobs, S. Cali, W. Rose

**RETROKIT- retrofitting residential multi-family buildings – Evaluation of effects on indoor environmental quality**

912  Y; De Kluizenaar*, P. de Jong, M. van Vliet
ID77 Test methods for emissions - D. Heikens

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85 V. Fabi*, V. Barthelmes, S. Corgnati

Developing an ASTM International Method for Measuring Emissions from Spray Polyurethane Foam (SPF) Insulation with Micro-Scale Chambers
110 J. Sebroski*, C. Thompson, J. Miller

Measuring and Characterizing Tris(2-chloro-1-methylethyl) Phosphate Emission from Open Cell Spray Polyurethane Foam
178 D. Poppendieck, M. Gong*

The influence of chamber size on chemical emissions from open and closed cell spray polyurethane foam
862 D. Poppendieck*, M. Gong
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ID81 Hospital/clean room - A. Hathway

Thermal comfort of the surgical staff in an operating room: a numerical study on laminar and mixing ventilation systems
233  S. Sadriadeh*, S. Holmberg

Numerical Simulation and Experiment Validation of Ventilation Performance of Horizontal Airflow Pattern in Bone Marrow Transplantation Ward
496  Y.-L. Wu*, J.-J. Zhao, S.-x. Liao, S.-T. Li

Locally Adjusted Floor Tiles for Energy-Efficient Cleanrooms
499  B. Zielke*, M. Kriegel

Performance of protective local laminar air supply in hospital isolation rooms
577  P. Kalliomäki*, P. Saarinen, J. Tang, H. Koskela

Study on the impact of circulating nurse walking on bacteria-carrying particles distributions in operating theatre
798  J. Wang*, T.-t. Chow, B. Yang, T. Olofsson, H. Zhang

Air contamination control in Hybrid operating theatres. Particle content during different types of surgery with focus on diathermy
998  F. Romano*, J. Gustén, S. De Antonellis, C. Joppolo

On field ventilation performance in operating theaters against airborne contamination: a comparison of unidirectional and mixed airflow systems
1003  C. Joppolo*, F. Romano, R. Ricci, S. De Antonellis, J. Gustén

Design of air distribution system in operating rooms - theory versus practice
1102  M. A. Melhado*, M. Loomans, J. Hensen, R. Lamberts

Air flow velocity generated by door motion based on 1:10 scale experiments
1187  A. Hathway*
1.3 Morning presentations
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Indoor air quality (IAQ) is an important determinant of health and wellbeing. In contemporary societies people spend most of their time in indoors, in houses, schools, offices and inside vehicles. Improper or poor ventilation of combustion appliances poses a risk for acute carbon monoxide intoxication, and exposures to radon and environmental tobacco smoke increase lung cancer risk. A variety of indoor chemicals may cause adverse sensory effects, leading to discomfort and other symptoms, or even effects such as respiratory disease, allergy and irritation of the respiratory tract. Improper or poor ventilation can also lead to damp buildings and mold. Therefore, in 2000 WHO has published ‘The right to healthy indoor air’ (EUR/00/5020494), in which under the principle of human right to health, it was stated that everyone has the right to breathe a healthy indoor air. The provision of a healthy air for citizens is therefore an important governmental objective. By organising scientific studies and validation projects, policy and legislative strategies for a healthy IAQ are designed and operationalized. These include actions for source control, guidelines for effective ventilation, targeted assessment campaigns, the design of sensitisation initiatives, preventive and remedial actions as well as an emerging issues policy. Because of its multidisciplinary character, various policy units’ activities are related to the creation of a healthy indoor air for citizens. They include environmental councils, energy agencies, social housing, education and product policy departments, building councils, and public health services. Each department organises its preparatory research activities and designs its policy strategy based on research outcomes. The multidisciplinary approach that would reflect the typical character of IAQ, and would thus involve several governmental departments and disciplines, is most often not applied at this level.

Our experience learns that the multidisciplinary character of IAQ research should be reflected in policy and legislation in order to result in effective and advantageous initiatives for public health. An integrale approach, involving an open dialogue between all related policy units shows to be beneficial for stimulating a healthy IAQ and defining effective policy initiatives for citizens. This debate on the value of scientific work, policy research, and practices and its outcomes will be related to the value of citizen sensitisation initiatives, the role of building designers, legislative measures, and the importance of simple
preventive and remedial actions. Based on international best-practices and know-how, various initiatives and strategies will be illustrated. By presenting a number of inspiring success stories as well as bottleneck situations and obstacles, an interactive discussion on best-practices for bridging the gap between research and policy will be stimulated.

Introduction
K. Van Campenhout

Air quality indoors and outdoors - Joint harmonization efforts in a diverse network of interacting scientists
S. Nehr*

Do building industry professionals and stakeholders believe what IAQ experts think is true?
A. Rackes*, M. Hamilton, P. Gurian, M. Waring

How to Evaluate Ventilation in IAQ Studies
A. Persily*

Potential policy impact of REACH (Article 68.2) on CMRs present in indoor air in the EU and the related consumer exposure
L. Geerts*, K. De Browere, M. Lor, D. Van Raemdonck, B. Joiret

Discussion
The workshop aim is to discuss whether and how ozone-initiated terpenoid chemistry causes adverse health effects in non-industrial environments. An emphasis on the potential to combine reactive chemistry models and health-based structure reactivity models to improve indoor air quality.

Presentations will deliver: 1) If and how modelling can predict personal exposure of gaseous oxidation products versus secondary organic aerosols and how they are sampled and analyzed. 2) What has toxicological testing taught us? 3) What has health effects research shown us? 4) What has field and chamber testing shown us? Our goal is to synthesize and conclude together with attendees: Can we predict how ozone-initiated terpenoid reaction products and secondary organic aerosols cause health effects and under what circumstances?

**Overview**

R. Wells

**Role of Oxidants: sources and impact on indoor air quality**

C. Schoemaecker

**How far can modeling go about personal exposure to reactive chemistry**

N. Carslaw, M.S. Waring

**State-of-the-science of measurement/sampling techniques**

J. Ham

**State-of-the-science of toxicological testing**

I. Nelissen, P. Wolkoff

**Discussion/Conclusion**
The built environment is one of the largest users of (fossil) energy. Energy savings can be achieved by better insulation and energy-efficient equipment. But still large deviations for individual households are seen. Present thermal comfort models and design guidelines are mainly based on an average man exposed to a quasi-steady state uniform heating or cooling. However, such average man does not exist. That is why the percentage people dissatisfied (PPD) cannot be lowered to less than 5%. Since the limits for energy improvements are being reached in a short term, new or improved models are needed to lower the PPD. These new models should be able to predict the thermal sensation of specific groups of people (e.g. male/female, young/elderly) or individuals, but should also be simple enough to be used during the building design. For improving and individualizing the thermal sensation models, new steps on local aspects are needed, e.g. on local and dynamic clothing insulation, local heat production and relations between local skin temperatures and local as well as global thermal sensation. For making these steps, some knowledge and data is missing or, if available, not yet published in international journals, but only in internal reports or in Master and PhD theses that are not open to others.

The goal of the session is to discuss new ideas, the missing links and solutions how to obtain the missing data in order to improve the state-of-the-art models. The general discussion should aim to enlarge the given figure, but also to provide knowledge of research and literature on supposedly missing data as well as to discuss how to translate and implement this knowledge into practical guidelines for designers and building engineers. In this way the PMV/PPD models will be individualized and the standards can be brought to the requirements of the 21st century.

Introduction
A. Frijns, S. Veselá, B. Kingma

Challenges in modelling local thermal sensation
S. Veselá*, B. Kingma, A. Frijns

A Model for Calculating Heat Transfer in Human Body under Transient and Non-Uniform Thermal Environment
D. Lai, Q. Chen*
Thermoregulation model JOS-2 and prediction of local thermal comfort
706  S. Tanabe*, Y. Ozeki, M. Ogata, H. Miyajima

Systematic comparison of the existing widely used thermal sensation models
1052  B. Koelblen, A. Psikuta*, A. Bogdan

Discussion
Developing Observational Indices for Dampness and Mold to Protect Health - Towards Improving Causal Research or Towards Supporting Practice? - M. Mendell

Measured microbiological factors have not correlated consistently with dampness-related health effects, but specific indicators of dampness or mold have. Multiple research groups are now focused on developing combined indices of observed dampness and mold that further improve correlation with health effects. Successful multi-level exposure indices, allowing demonstration of dose-response relations with health, could support health-protective guidelines. Two different types of goals can guide such research. Some research, in the epidemiologic tradition, has focused on improving exposure indices to have stronger correlation with health effects in studies. Greater complexity in indices may produce stronger associations and better indicate causal links, even if not feasible for wide use. Other research has focused on simpler, more practice-oriented observation-based metrics of D/M that are feasible for field use, some of which have surprisingly strong, dose-related associations with health. The epidemiologic literature on this topic has not explicitly discussed this distinction. Since identical research activities could likely work towards the benefit of both goals, which can be complementary, explicit discussion of this issue between research groups could be advantageous for the public health.

Introduction
M. Mendell

Observed Dampness and Mold Metrics in Health Research at US NIOSH
J.-H. Park

Observed Dampness and Mold Metrics in Health Research at the National Institute for Health and Welfare, Finland
J. Pekkanen

Observed Dampness and Mold Metrics in Health Research at the University of Cincinnati
T. Reponen

Review and Synthesis
M. Mendell

Discussion
This session focuses on studies of particle filtration effectiveness in buildings with special attention to study design, metrics and results.

Filter effectiveness may be reduced for secondary organic aerosol (SOA): Impact of re-equilibration of semivolatile products to aerosol phase 859 C. Wang*, M. Waring

Evaluation of Exposure to Ozone and Ultrafine Particles due to Electrostatic Precipitator Operation 549 J. Xiang*, J. Mo, D. Day, L. Fang, C. Weschler, Y. Zhang, J. Zhang


Assessment of indoor PM2.5 among different ACMV systems during the 2015 Southeast Asian haze episode 773 G. Parshetti, X. Ding, C. Sekhar, D. Kok Wai Cheong, K. Wai Tham*

In-situ integrated HVAC filter efficiency 1033 M. Alavy, J. Siegel*

Measurement-based evaluation of ventilation and filtration systems for reducing outdoor PM 2.5 in a modern California detached house 1124 B. C. Singer, W. W. Delp, D. R. Black, I. S. Walker
ID4 Exploring issues of indoor air quality with respect to structures resultant from the design and implementation of adaptive reuse of historic structures - J. Murphy

This session is intended to present and summarize the special circumstances that historic structures may present in the realm of maintaining or improving indoor air quality for occupants in spaces that are the result of adaptive reuse interventions of historic or antiquity buildings. State of the art for same may be presented, should this topic area have proceeded to that point of inquiry within the existing discipline.

Indoor Air Quality and Interior Environmental Conditions for Adaptive Reuse of Historic Structures: A case for research and development of guidelines
80 J. Murphy Jr*

Renovation of a single family house in a social housing garden city in Brussels as private-public collaboration: Ambitious targets for energy, indoor climate and post-occupancy monitoring.
87 P. Foldbjerg*

Assessing how retrofit of traditional buildings impacts indoor environment and occupant’s thermal comfort
170 E. Essah*, V. Elliston

Indoor Air Quality, thermal comfort, and occupant behaviour in retrofitted energy efficient homes
440 Á. Broderick*, M. Byrne, M. Coggins

New Approach to Indoors Air Quality Assessment for Cultural Heritage Conservation
784 D. Leyva Pernia*, S. Demeyer, O. Schalm, W. Anaf, C. Meert
ID6 Sampling and analysis of emissions from Spray Polyurethane Foam (SPF) insulation - D. Poppendieck

SPF insulation is spray-applied on site, therefore, standardised methods are needed to assess the potential impacts of SPF insulation products on indoor air quality and to establish re-entry or re-occupancy times after product installation in a building. Potential emissions may include volatile and semi-volatile organic compounds used in the formulation (e.g. isocyanates, blowing agents, amine catalysts and flame retardants) and from potential reaction or byproducts. Ventilation requirements also need to be considered during and after spraying. Over the past five years the ASTM D22.05 subcommittee on Indoor Air has been developing consensus standards to assess chemical emissions of SPF insulation products. These standards cover: spraying, sample preparation, packaging, specimen preparation, estimating emissions of volatile and selected semi-volatile organic compounds (e.g. blowing agents, catalysts and flame retardants) with micro-scale chambers followed by analysis with thermal desorption GC/MS. These methods are designed to standardize the assessment of emissions from SPF allowing qualitative evaluations of indoor air quality impacts.

The objective of this session is to provide a forum for the presentation of recent research regarding SPF emissions sampling, field experiments and exposure modeling. The goal of the session would be to facilitate the exchange of ideas from SPF manufacturers, regulatory agencies, indoor air quality professionals, testing labs, air quality consultants, instrument vendors, and other interested parties.

Topics to discuss:

1. Current status of ASTM methodology

2. Validation of methods
   - ILS study
   - Chemicals to be analysed

3. Future efforts:
   - Modelling parameters
   - Large chambers/field studies
   - Methylene diphenyl diisocyanate (MDI) emissions
ID5 Environmental airflows and how they may lead to isolation/containment failure in critical hospital/healthcare settings - J. Tang

To identify potential sources of isolation/containment failure (e.g. like door-opening motions +/- people movement), and possible methods to reduce/prevent this (e.g. increased negative pressure within the isolation room, increased positive pressure anterooms, use of sliding vs hinged doors, use of air curtains across the doorway or around the patient bed – as long as the patient is mostly non-ambulatory). At the end of this session we would like to have a list of potential sources of isolation/containment failure and possible, practical, effective solutions/interventions that can be implemented in real, every day, healthcare settings, like hospitals and clinics. We would like to invite submissions/abstracts/oral presentations on the two following questions: Q1 – the problem: What sources of environmental airflow may cause a failure in isolation/containment? Hinged vs sliding doors? Doors opening too quickly for too long? People moving through doorways? Too low a pressure differential across doorways in the presence of such movements? Lack of an anteroom? Ventilation mode/rate? Placement of supply vs exhaust vents? Use of airtight vs ‘leaky doors? Q2 – possible solutions: What interventions/solutions can reduce isolation/containment in this airborne/aerosol infectious agent context? Use of sliding doors? Increased pressure differential across doorways? Use of air curtains across the door, around the bed, or both? Use of positive pressure anterooms? Similar considerations for positive pressure protective isolation for transplant patients (e.g. to exclude Aspergillus spores and other potentially airborne/aerosol-transmitted pathogens?

Experimental investigation of human-walking-induced wake flow: experiments by Particle Image Velocimetry (PIV) 81 N. Luo*, W. Weng, M. Fu

Possible double-route transmission of SARS in the largest nosocomial outbreak in Hong Kong 472 S. Xiao*, Y. Li

Door opening and simulated human passage induced airflows through a hospital isolation room doorway 556 P. Kalliomäki*, P. Saarinen, J. Tang, H. Koskela

Subjective Evaluation of the Microenvironment Generated by a Hospital Bed with Localized Ventilation System 651 N. Kehayova*, Z. Bolashikov, A. Krikor Melikov
Modelling transient airborne infection risk in hospital corridors

R. Wood, C. Noakes*, D. Borman, A. Woods
1.4 Afternoon presentations
| 14:00 -15:30
| PLA C-K
ID40 Indoor Air Quality and Related Low-Cost Solutions in School Buildings - R. Corsi

The aim of this “session” is to share recent advances related to indoor air quality in schools and (importantly and often neglected) low-cost and practical approaches to solving those problems. An important outcome will be a five-year research agenda that is derived from presentations and audience discussion.

Introduction

Particulate matter in urban nursery schools in a mega-city, Seoul, Korea
148  D. Rim*, G.-N. Bae, J. Bum Kim

Improving ventilation in portable classrooms: simple, low cost solutions
919  S. Bourne*, A. Novoselac, K. Kinney, J. Maestre

Healthy High School PRIDE (Partnership in Research on InDoor Environments)

Improving air filter efficiency as a strategy to reduce children’s exposure to traffic related air pollutants in energy-efficient classrooms

Discussion
MONDAY 14:00 - 15:30 PLA C

**ID1197 Indoor Surface Chemistry - J. Abbatt, M. Shiraiwa**

It is well recognized that surface chemistry is of important to indoor air, with high surface area-to-volume ratios and long residence times for deposited species. The composition of indoor surfaces is affected by a wide number of species that are deposited from the air, as well as by the properties of the building materials themselves. Both oxidation and partitioning processes are important as these surfaces interact with the surrounding air.

*Surface interactions as a source of potentially harmful species in indoor air*

141 M. Kruza*

*Kinetic modelling of multiphase reactions between O3 and skin lipids*

239 P. Lakey*, T. Berkemeier, U. Pöschl, M. Shiraiwa

*Probing indoor air chemistry through gas phase and surface measurements*

390 S. Liu*, S. Thompson, J. Krechmer, R. Li, R. Wild, C. Warneke, J. de Gouw, S. Brown, S. Miller, J. Luongo, J. Jimenez, P. Ziemann

*Exploring the nature of indoor oxidative heterogeneous chemistry*

564 S. Zhou, R. Alwarda, M. Forbes, J. Abbatt*

*Correlation between physicochemical properties of natural building materials and adsorption behaviour of volatile organic compounds*

920 C. da Silva*, C. Rana, K. Mower, M. Ansell, A. Dengel, R. Ball
**ID125** STC 33 meeting - Thermal comfort: Theory and practice - Y. Zhu

The aim of this session is to consolidate the international connections within the thermal comfort society. Both STC33 members and non-members are welcome to join the meeting and share the state of the art on information or ideas in their newest research. A discussion is also expected on how STC33 could play a more effective role in collaborating researchers and contributing solid outcomes to the society.

**IEA-EBC project “Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings”**
Y. Zhu*

**Presentations about thermal comfort: theory and practice**
B. Cao, R. Hellwig, Y. Zhu

**Discussion**
ID2014 E-cigarette - B. Offermann

Formaldehyde and Acetaldehyde Emission Rates From E-Cigarettes
1205 F. Offermann

Numerical Prediction of Contaminant Distribution in Human Respiratory Tract for Exposure Assessment to E-Cigarettes

Environmental Exposure to Nicotine from Electronic vs. Conventional Cigarette Smoke: A Pilot Study
1207 Z. Dunbar, L. Vogl, M. Palumbo, M. Travers, M. Goniewicz

Indoor vaping: composition and health impacts of mainstream and secondhand emissions

Discussion
**ID29 Indoor Environment Data Collection with Today’s Technology - B. Stephens**

As computer hardware and communication technology rapidly advances, data collection for scientific research has not been catching up to leverage these advances. In the field of building sciences, we can now do more for cheaper, if the researchers can understand and utilize these technologies. In this session, we would like to first discuss the possibility of using off-the-shelf technology parts to build cost effective sensors that can help researchers to obtain the field data one often misses either due to the expenses or the practicality of equipment limitations. We will then discuss data transformation in the world of internet connected devices as it relates to building science and indoor air. What traditionally seemed impractical in terms of field study is now possible due this interconnectivity, but harnessing this networking power can be challenging for researchers who are not familiar with IT advances. We then will open for questions from the audience and will generate discussion on the methods and concepts introduced. Intended discussions include: 1) should I spend the time and money to build my own sensors for my research? 2) What are the accuracy, reliability, and cost issues and what do I care most about in data collection and measurement? 3) What do I really need to know about Internet and data in terms of it benefiting my research? 4) Should I be worrying about data breaching for my research?

**Introduction**

**A Wireless Indoor Environment Sensing System and Data Analysis Methods**

H. Zhou*, X. Zhou, Y. Zhang, D. Chai, Y. Li, L. Qiao, Y. Jiang, H. Sun

**Exploration of Family Composition Based on Indoor Noise Data A Data Mining Approach**

H. Zhou*, Y. Jiang, H. Sun

**A novel approach to occupany estimation using motion and CO2 sensors**

KH. Han*, B. Morris, T. Labreche, J. McMahon, S. McMahon, J. J. Zhang

**Developing HMI of the iMOD Sensing and Consulting System for Indoor Environment Health**

N.-T. Chen*, Y.-S. Chen, J.-Y. Lin, K.-S. Liu, Y.-S. Tsay, Y.-R. Dong

**Discussion**
MONDAY  14:00 - 15:30  PLA I

**ID1203** A new standard and guideline on indoor environmental parameters for design and energy evaluations of buildings EN16798-1 and TR16789-2 (EN15251revised) - B. Olesen, A. Boerstra

The standard will be shortly introduced. During the development of the standard several issues were discussed and it was often difficult to get clear conclusions. In the workshop the most important issues will be discussed and feedback is asked from both the research community and the users of the standard. The standard is dealing with all four indoor environmental parameters, thermal, air quality, illumination and acoustic. The standard specifies indoor environmental parameters/criteria for design of buildings and building service systems and for input values to energy calculations. These criteria are listed as default values in an informative annex. Another similar annex without default values are then prepared for listing of national criteria expressed in the same way; but may be different or a subset of the given default values.

**Modelling the Fate Of Bioaerosols in Hospital Rooms**

*216* M.-F. King*, C. Noakes, A. Sleigh

**M1-class for office furniture with textile coverings and paddings**

*279* L. Sariola*, H. Järnström, J. Sateri

**The Role of Indoor CO2 Concentrations in Ventilation and IAQ Standards**

*338* A. Persily*

**Development and Investigation of Indoor Air Quality Index and Thermal Comfort Index**

*1097* J. Cheol Kim, B. Hyoek Lee, T. Kim*, K. Hwan Lee, S. Kang, S. Yong Lee
There is a need to enlarge the borders of knowledge in the field of consumer products emissions and associated impact on indoor air quality in indoor spaces, such as dwellings and offices. The session is looking for some answers related to the questions such as a) what specific pollutants are emitted that may influence the indoor air quality and adversely affect occupants; b) how the emission profiles change over time and c) are the emission test results meaningful - i.e. are the results independent of test conditions.

Use of large-scale test chambers for measuring emissions from furniture: results from an inter-laboratory comparison
190 C. Yrieix*, M. Nicolas, M.-L. Roux, F. Maupetit

Cleaning sprays – aerosol characterization and a human exposure chamber study
328 C. Isaxon*, K. Lovén, J. Nielsen, A. Gudmundsson

Product Emissions by Laboratory Testing. The EPHECT Project Experience.
422 J. Bartzis*

Evaluation of volatile organic compounds and particulate emissions of incense and candle in emission test chamber: impact of test parameters
573 P. Garnier, E. Quivet*, G. Karr, A. Albinet, F. Maupetit, M. Nicolas

Impact of environmental gradients on aerosol composition measured with real-time aerosol mass spectrometry
683 M. Waring, P. DeCarlo*, A. Johnson

Room fragrances – sprays and diffusers as sources of indoor pollutants.
1005 E. Uhde*, N. Schulz
ID1202 Air quality in specific environments - B. Hanoune

The aim of this session is to present recent studies aiming to characterize the indoor air composition of various environments. Preference will be given to studies describing the full chemical characterization of these environments over to studies focusing on one type of contaminants (eg. studies on particulate matter or carbonyl compounds only), which will be presented as posters in associated sessions.

Influence of fuel change on indoor environmental quality on-board a passenger ferry
78    S. Langer*, J. Moldanova, C. Österman

Indoor air quality in professional maintenance and cleaning service rooms
138   M. Hyttinen*, J. Ruokolainen, T. Aarni, P. Pasanen

Indoor air quality in French hospitals: large scale sampling campaigns and first physical-chemical results

The effectiveness of the indoor air quality improvement project in an office building - a case study
823   R.-Y. Chen*, C.-Y. Yeh, J.-F. Lin

Air contaminations in a craft brewery
993   M. Dudzinska, B. Polednik*, J. Czerwinski

Measurement of indoor air pollutants of a newly built museum in Japan
1061  M. Yuda*, N. Kagi, Y. U, M. Kouyama, M. Kasahara
1.5 Afternoon posters
| 16:00-17:00
| UFO I-VIII
Air filtration for the control of the particle concentration within a school equipped with a balanced ventilation system

A. Ginestet*, D. Pugnet, M. Robitu

Multiple exposures in public primary schools in dependence of building characteristics – Cologne Program Active Health Care

A. Keulers*, G. Wiesmüller, C. Kaesler, G. Barth, W. Dott

The importance of building factors on indoor radon concentrations: preliminary survey in schools

J. Madureira*, I. Paciência, J. Cavaleiro Rufo, M. Pinto, A. Moreira, A. Pereira, E. de Oliveira Fernandes

Phthalates esters in the dust/soil of Elementary schools

C.-Y. Lee, C.-N. Huang, C.-W. Lee*

Improving indoor air quality in New Zealand classrooms with a solar ventilation unit: the air particulate part


Air pollutants transfers from roads in the schools of Lille

E. Roux*, C. Bugajny

Characterization of indoor and outdoor particles of primary school classroom in Chongqing, China and its impact on children

J. Xiong*, W. Yu, R. Yao, B. Li

Comparative personal exposure assessment of school children to particle number concentrations in Australia, Italy and Bhutan

L. Morawksa, M. Mazaheri*, G. Buonanno, S. Clifford, F. Fuoco, T. Wangchuk
<table>
<thead>
<tr>
<th>ID</th>
<th>Title</th>
<th>Authors</th>
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</thead>
<tbody>
<tr>
<td>360</td>
<td>Particle resuspension from a surface when swept by a hairbrush</td>
<td>T. Zhang*, R. Xie, S. Wang</td>
</tr>
<tr>
<td>370</td>
<td>Influence of suspended particles on convective mass transfer of SVOCs at flat surfaces under non-equilibrium state</td>
<td>J. Cao, X. Zhang, Y. Zhang*</td>
</tr>
<tr>
<td>457</td>
<td>Endotoxin Concentration in House Dust and Indoor Air in Japan</td>
<td>H. Kim*, E. Lim, N. Kagi, K. Azuma, Y. U, H. Osawa, M. Hayashi</td>
</tr>
<tr>
<td>466</td>
<td>Semi-volatile organic compounds in French dwellings: an estimation of concentrations in the gas-phase and airborne particles from settled dust</td>
<td>W. Wei*, C. Mandin, O. Blanchard, F. Mercier, M. Pelletier, B. Le Bot, P. Glorennc, O. Ramalho</td>
</tr>
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<td>505</td>
<td>Main parameters of indoor air with innovative surfacing materials based on natural sylvite</td>
<td>K. Chernyi*</td>
</tr>
<tr>
<td>513</td>
<td>Assessment of volatile organic compounds and formaldehyde exchanges at the air/material interface of building products and their assemblies: towards improving selection criteria of building materials</td>
<td>A. Gross*, P. Mocho, H. Plaisance, C. Cantau, C. Yrieix, V. Desauziers, N. Kinadjian</td>
</tr>
<tr>
<td>530</td>
<td>Hygiene inequality in indoor surface environment</td>
<td>H. Lei*, Y. Li</td>
</tr>
<tr>
<td>878</td>
<td>Sorption of Organophosphorus Flame-Retardants on Settled Dust</td>
<td>X. Liu*, M. Allen, N. Roache</td>
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</tbody>
</table>
ID110 Human emissions - C. Weschler

Skin moistness influences human emissions of biological aerosol particles
184 J. Zhou*, W. Fang, W. Nazaroff, V. W.-C. Chang

Human CO2 generation rate calculation based on field measurement of CO2 concentration in a naturally ventilated room
223 G. Fan*, J. Xie, J. Liu

Real-time measurement of personal exposures to carbon dioxide
508 E. Gall*, T. Cheung, I. Luhung, S. Schiavon, W. Nazaroff

Infant Crawling-Induced Particle Resuspension: Size-Resolved Resuspension Rates Derived from a Three-Zone Model
ID63 (E)-cigarettes and 3d printers - Y. Hashimoto

Numerical Study on the Influence of Smoking Load in a Smoking Room with Displacement Ventilation and Mixing Ventilation
121 Y. Hashimoto*, H. Takahashi

Evaluating and controlling human exposure to ultrafine particle and VOC emissions from desktop 3D printers
266 D. Zhao*, B. Stephens, P. Azimi

A preliminary study for nicotine exposure of the passive smokers by using passive sampler
397 T. Amagai*, Y. Miyake, Q. Wang, H. Bai, M. Noguchi, S. Nakai

Study of collection instruments for nicotine from ETS to investigate the personal passive exposure
467 Y. Suzuki*, M. Noguchi

Fine Particulate and Chemical Emissions from Consumer 3D Printers
643 A. Davis*, M. Black, R. Weber, Q. Zhang, J. Wong

Behavior of nicotine in the environmental tobacco smoke (ETS)
664 M. Noguchi*, A. Yamasaki, Y. Suzuki

Numerical Prediction of Contaminant Distributions in Human Respiratory Tract for Exposure Assessment to E-Cigarettes
748 K. Kuga*, T. Matsuo, S.-J. Yoo, K. Ito

VOC and particle emissions from home and hobby 3D printers
899 S. Hartikainen*, M. Johansson, M. Hyttinen, P. Pasanen
MONDAY  16:00 - 17:00  UFO V

ID112 IAQ measuring techniques  -  A. Janssens

Rapid determination of the adsorption isotherm based on the parallel exponential kinetics model
67    C. Feng*, Y. Cui, D. Wang

Passive air sampling of cyclic volatile methyl siloxanes
97    C. Michelle Wang*, A. Kierkegaard, A. Lewis, N. Carslaw

A colour sequence enhanced particle streak velocimetry
212   H; Wang, X. Shao, X. Li*

Non-destructive techniques to evaluate moisture in buildings’ components as a tool for a better indoor environment
493   E. Barreira*

Modelling the Centreline Velocity of Non-Isothermal Air Jets with Arbitrary Flow Trajectories
516   B. De Clercq*

Biosensor human blood“: Assessment of indoor air quality with a human-specific method
569   H. Finger*, C. Asbach, S. Fennrich, S. Stoppelkamp

The 40 m3 Innovative experimental Room for Indoor Air studies (IRINA): development, validation and operation
594   P. Harb, S. Loganathan, F. Thevenet*, V. Gaudion, N. Locoge

Influences on Core Size of Local Unidirectional Flow Fields
804   H. Rotheudt*, B. Zielke, M. Kriegel

Evaluating the net escape probability distribution of contaminant from a local point to exhaust outlet in indoor environment
1154  E. Lim*, K. Ito, M. Sandberg

Comparisons of results from VOC measurements in one office, one residence and a spiked sample from nine laboratories in Sweden and Finland
1177  B. Glas*, M. Kempe, A.-S. Claeson
ID101 IEQ perception - R. Kramer

Thermal comfort of people in rural areas of the hot-humid region of China  
226 Y. Zhang*, Z. Zhang, L. Jin

Thermal comfort in a naturally ventilated high-rise residential building  
229 X. Zheng*, S. Kurvers, P. van den Engel, R. Schipper, P. Bluyssen

How individual IEQ factors affect passengers’ overall satisfaction in Chinese airport terminals? A questionnaire study supported by environmental measurements  
339 Y. Geng*, J. Yu, B. Lin

Validation and comparison of thermal comfort models against experimental data  
364 Z. Fang*, Y. Cheng, J. Z Lin

Thermal environment and comfort in semi-open and interior spaces of folk houses in hot-humid area of China  
371 L. Jin*, Y. Zhang

Improvement of the Thermal Environment at Japanese Facilities for the Elderly  
408 N. Kaihara*, M. Hayashi, K. Hoon, M. Bando, H. Osawa

Adaptive Temperature Limits for air conditioned museums in temperate climate regions based on measurements and 1200+ surveys  
492 R. Kramer*, L. Schellen, M. Doornbos, H. Schellen

Assessment of indoor environmental quality on occupant satisfaction and physical parameters in office buildings  

Analysis on Performance of Lightweight Insulation Roof  
713 X. Shen*, L. Li
MONDAY 16:00 - 17:00 UFO VII

ID76 Influence of ambient conditions on emissions - N.-y. Hsu

Emission of Phthalates and Phthalate Alternatives from Vinyl Flooring and Crib Mattress Covers: The Influence of Temperature
111 Y. Xu*, Y. Liang

Phthalates Uptake by Settled Dust on Polyvinyl Chloride Flooring and the Influence of Temperature
177 Y. Xu*, C. Bi

Experimental study of personal exposure to pollutants released at floor level: floor heating vs air heating
181 L. Gagytė*, A. Jurelionis, T. Prasauskas, D. Martuzevicius

Impact of humidity on the emission characteristic parameters of VOCs in building materials: experiment and Validation
197 C. Cai, S. Huang, W. Xu, Y. Zhang*

A comparative survey about whether the indoor thermal environment shift occupants’ comfort evaluation
215 W. Ji*, M. Luo, B. Lin, Q. Ouyang, Y. Zhu

Impact of humidity on emission parameters of formaldehyde from a medium density fiberboard
314 M. Lv, W. Liang, X. Yang*

Higher moisture content associated with the greater emission of DEHP from the plastic wallpaper

Multivariate analysis of VOC emissions from moisture damaged wall structure – a preliminary examination

Influence of moisture against acetaldehyde emitted from wood-based materials
ID94 IAQ industries and various environments - A. Berg

Numerical Study of Natural and Mechanical Smoke Ventilation in Industrial Complexes
309  A. Berg*, S. Rott, M. Schmidt

Influence of Industrial Activities on Indoor Air Quality and Respiratory Health
337  S. Mentese*, M. Tatman Otkun, A. Mirici, E. Palaz, D. Tasdibi, O. Cotuker, C. Bakar, S. Cevizci

Exposure to nanoparticle emissions inside firing ranges
427  M. Viana*, A. S. Fonseca, A. Alastuey, X. Querol, A. Rodríguez

Assessment of endotoxin exposure at biogas production plants in Sweden
570  E. Bloom*, B. Sahlberg, M. Remberger, M. Bibi, E.-L. Härnwall, A.-B. Antonsson

Exposure and Health Risk Assessments of VOCs nearby Dyeing Industrial Complex
663  J. Shuai*, W. Yang

Dynamic downscaling analysis of air quality from urban to human scale: Part 2 Exposure concentration in a large factory space
721  A. Murga*, Y. Sano, K. Ito

A case study: maintenance of cleanliness in a high power laser facility
908  Y. Yu*, E. Long

Safety and Health Risk Perceptions: A Cross-Sectional Study of Nail and Hair Salon Clients
1010  L. Milich, D. Shendell*

Monitoring of Indoor air in different working environments of different factories in Punjab, Pakistan
1.6 Afternoon keynotes
| 17:00 - 18:00
| UFO main auditorium
Disentangling Sustainable Building Research and Design for IEQ
Hal Levin - Building Ecology Research Group

Sustainability is a complicated, much-used overly generalized construct in building design and research. A multi-faceted, multi-stage approach can identify the issues and disentangle them. There are several viable technical (science-based) approaches to identifying the resource and pollution implications of available choices. Ultimately decisions depend on values and treatment of uncertainty.

A more widely-accepted and more specific definition or meaning for the term “Sustainability” is possible using Andrew Dobson’s framework for clarifying the implicit basis for sustainability claims. The framework enables a globally consistent, context-specific basis for building research and design and enables us to clarify the meaning and value-based choices implicit in our sustainability definitions.

Conflicting values result in different decisions (in research and building design). Blind assumptions (rarely made explicit or discussed) are made that knowledge and values are shared while careful examination of decisions reveals that fundamental differences exist in the perceptions of the human health and ecological problems being addressed and the different values held by different decision-makers.

Ecological and human health issues exist at global, regional, and local scales; while they can be interdependent, they only partially overlap; Decisions regarding trade-offs between diverse goals and objectives made using systematic approaches for analysis and choice processes can minimize suboptimized solutions to one environmental problem that may conflict and even controvert solutions to a different problem.

Matters of fact (from scientific knowledge) are often uncertain or disputed so that knowledge-based decision-making depends strongly both on the state of the science, the decision-makers and the context. Attitudes toward risks differ as to who should bear the burden of decisions affecting risk. For instance, European vs. American attitudes diverge toward the role of knowledge in adopting a policy on risk when relevant uncertainty is involved.

Ethical choices are embedded in our sustainability choices. For example, the trade-offs between increasing ventilation to improve IAQ or air-conditioning to
improve occupant thermal comfort illustrate this choice for both research and design. Decisions made only on economic costs and benefits ignore important, non-monetary costs and ethical values of ecological services and human social values.

We describe a three step process for an improved and more open and shared understanding of the term “sustainability” in our building environmental research and designs.

1. Clearly define and prioritize environmental and human challenges (problems, issues?) considered important for sustainability human life on Planet Earth and on ecological health.

2. Specify acceptable limits for human resource consumption, pollution emission and land use on an appropriate scale for each major ecological or human health problem: global, regional, and local.

3. Identify the impacts of each viable choice and use importance-weighted criteria to select the most sustainable solutions.

To address issues of sustainability designers should consider the implications of widespread application of their design solution to similar buildings in the geographical context as well as in the regional and global context and to use a consistent framework for the necessary trade-offs. An agreed definition of sustainability can provide guidance in decisions affecting the design and implementation of building research and design/development.
KEYNOTE 2

Old and new currents in research ethics and epistemology: the case for IAQ
Mariachiara Tallacchini - Università Cattolica del Sacro Cuore - Piacenza, Italy

Ethics has become increasingly relevant in all scientific research and practice during the second half of the 20th Century. Its role evolved toward an instrument of “soft law” (non-legally binding principles) in regulating new techno-scientific domains. Three sets of issues mark the beginnings of contemporary ethical reflection: research integrity, experimentation on human subjects and the treatment of scientific and technological uncertainty.

While wide agreement and a number of codified principles exist for the first two set of issues, scientific uncertainty is still at the core of significant theoretical and policy debate, and new areas for reflection and concern have emerged.

The case of Indoor Air Quality science & technology exemplifies the complexities that scientific and professional communities, characterized by high reliance on interdisciplinary knowledge, have been and are currently facing. These include challenges ranging from harmonizing values often in conflict (e.g. human, animal, and environmental health; safety and productivity issues) to navigating the intricacies of emerging and converging technologies with unpredictable consequences.

ISIAQ’s Code of Ethics is a good starting point for some reflections presented here. It reveals that, while the Code provides guidance on many issues at the interface between epistemology and ethics, several problems remain open. Indeed, the Code deals with several issues of research ethics and integrity; however, it lists values which can often be in conflict; it touches lightly on “the limits of knowledge;” and it only refers to “the public” as the recipient of communication from scientists and professionals.

A brief and mostly impressionist introductory overview is offered on some of these current epistemological debates with their embedded ethical implications. These debates concern, for instance, the often intertwined issues of quality of knowledge and scientific uncertainties; divergent visions of privacy and data protection; new roles for citizens, alone or together with scientists as peer-producers, not merely as recipients, of science and technology for civic purposes (citizen and Do-it-Yourself science).
D A Y

2 TUESDAY
## Day schedule

**TUESDAY**

### DAY 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>2.1 8:30 - 9:30</td>
<td>Morning keynote</td>
<td>Main auditorium, UFO</td>
<td>T9 T2 T3 T8 T5 T6 T5 T9</td>
</tr>
<tr>
<td>2.2 9:30 - 10:30</td>
<td>Morning poster sessions</td>
<td>Foyer, UFO</td>
<td>T9 T2 T3 T8 T5 T6 T5 T9</td>
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<tr>
<td>10:30 - 11:00</td>
<td>Coffee break</td>
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<td>T9 T2 T3 T8 T5 T6 T5 T9</td>
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<tr>
<td>2.3 11:00 - 12:30</td>
<td>Morning presentations</td>
<td>Plateau</td>
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<tr>
<td>12:30 - 14:00</td>
<td>Lunch</td>
<td>De Brug</td>
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<tr>
<td>2.4 14:00 - 15:30</td>
<td>Afternoon presentations</td>
<td>Plateau</td>
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</tr>
<tr>
<td>15:30 - 16:00</td>
<td>Coffee break</td>
<td></td>
<td>T10 T7 T3 T8 T5 T3 T9 T9</td>
</tr>
<tr>
<td>2.5 16:00 - 17:00</td>
<td>Afternoon poster sessions</td>
<td>Foyer, UFO</td>
<td>T10 T7 T3 T8 T5 T3 T9 T9</td>
</tr>
<tr>
<td>2.6 17:00 - 18:00</td>
<td>Afternoon keynote</td>
<td>Main auditorium, UFO</td>
<td>T9 T2 T3 T8 T5 T6 T5 T9</td>
</tr>
<tr>
<td>19:00 - 22:00</td>
<td>Conference dinner + visit Gravensteen Castle</td>
<td></td>
<td>T6 T7 T8 T9 T10</td>
</tr>
</tbody>
</table>

- **T1** Society
- **T2** Chemistry
- **T3** Ventilation/Thermal comfort
- **T4** Health
- **T5** Modelisation
- **T6** Energy/Sustainability/Design
- **T7** Emission
- **T8** Microbiology
- **T9** Specific environments
- **T10** Tools

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2.1 Morning keynotes
| 08:30-09:30
| UFO main auditorium
KEYNOTE 1

Bringing atmospheric and surface chemistry indoors
Vicki H. Grassian - Distinguished Chair of Physical Chemistry, University of California San Diego

The Grassian laboratory is interested in fundamental molecular-based laboratory studies that provide a better molecular understanding of the surface chemistry of complex environmental interfaces. Several ongoing projects include understanding the molecular level details of the heterogeneous chemistry of trace gases with particulate matter such as mineral dust in the atmosphere, dissolution and mobilization of Fe-containing particles, optical properties of atmospheric aerosol and applications and implications of nanoscience and nanotechnology in environmental processes. The Grassian group applies the techniques and methods of surface science, aerosol science, microscopy and spectroscopy to study these problems.
KEYNOTE 2

How Ventilation Affects Schoolkids
William Fisk - Sr. Scientist, Indoor Environment Group, Lawrence Berkeley National Laboratory

Building ventilation rates influence building energy consumption and have been shown to affect indoor air pollutant concentrations, perceived air quality, health, absence, and cognitive performance. Factors mediating the relationships of ventilation rate with these parameters include outdoor climate, outdoor air quality, features of the building and its operation, and characteristics of occupants and their activities. Ventilation rates affect indoor concentrations of volatile organic compounds more strongly than concentrations of semi-volatile organic compounds and particles. Prevalence rates of sick building symptoms in office workers have been shown to have a dose-response relationship with ventilation rates; however, the underlying data are old. Only a few studies have investigated how ventilation rates influence absence - an under-utilized research outcome. In schools, ventilation rates are very often far below minimum requirements and lower rates are associated with increased absence. Many studies have found that higher ventilation rates increase aspects of cognitive performance. The extent to which the performance changes are a consequence of the changes in indoor carbon dioxide concentrations with ventilation rate remains uncertain due to inconsistent research findings. Economic analyses for work places find that the economic benefits from the improvements in health and performance with increased ventilation rate far exceed the energy costs. Priorities for future research include investigations of how ventilation rates in homes affect health, studies of the effects of ventilation rates on communicable respiratory infections, and further elucidation of the direct effects of carbon dioxide on cognitive performance. In addition, research should be directed at overcoming the widespread problem of low ventilation rates in schools.
2.2 Morning posters
| 09:30-10:30 |
| UFO I-VIII |
TUESDAY 09:30 - 10:30  UFO I

ID90 Museums, public and commercial buildings - C. Sekhar

Thermal Comfort and Indoor Air Quality study during Peak and Off-Peak Periods in a Naturally Ventilated and Air Conditioned Food Court in Singapore
151 C. Sekhar*, D. Koh

Assessment of the indoor environmental quality of Portuguese gymnasiums
476 R. Almeida*, N. Ramos, E. Barreira, M. Santos

New Weather-Feature Variable to Assess Energy Use under Tight Indoor Environmental Control in Historical Art Galleries
591 S. Ganguly*, F. Wang, Z. Chen

Levels of Volatile Organic Compounds in the National Archaeological Museum – Spain
610 O. Vilanova*, B. Sánchez, C. Canela

The impact of commercial activities on indoor air quality
763 G. Thiault*, L. Paillat, E. Faure, F. Rieunier, G. Goupil, L. Durupt, V. Eudes

Quality of the air in indoor swimming pools
991 M. Dudzinska*, B. Polednik, J. Czerwinski, A. Polednik
Towards the next generation of indoor air chemistry models
131  N. Carslaw

Exploration of the Influence of Nitrogen Oxides on Secondary Organic Aerosol Formation
173  R. Wells*, L. Cena

Measuring indoor ozone decay rate in China
196  W. Ji*, B. Zhao

Indoor air measurements of sub 3 nm particle number size distribution using Airmodus nano Condensation Nucleus Counter A11
242  J. Vanhanen*, M. Väkevä, E. Miettinen

The experimental study of ozone reaction with indoor VOCs from pinewood and its secondary ultrafine particle pollution
480  C. Ruiqing, P. Jing*, J. Liu

Measurements and modelling of OH and HO2 radicals in an indoor classroom environment during cleaning activities
644  D. Heard*, T. Ingham, N. Carslaw

Framework to predict indoor aerosol concentrations as a function of composition, temperature-based volatility, and deposition
959  M. Waring*, P. DeCarlo
ID66 IAQ modeling and bedroom IAQ - B. Boor

Long-Term Gas Pollutant Concentration Monitor of New Student Dormitories with Natural Ventilation
614 Y. Yin*, P. Jing, J. Liu

A numerical study on three different ventilation modes in a general ward in sleeping environments
747 M.-Y. Chan*

Indoor air quality during sleep: characterization and exposure assessment
1012 N. Canha*, S. Candeias, S. Almeida

The comparison between kinetic theory and mass transfer models to predict service life of activated carbon filters in removing VOCs
356 A. Khazraei Vizhemehr*, F. Haghighat

Backward Probabilistic Model for Identifying Contaminant Source in Air Duct System
604 J. Gao*, L. Zeng

The Importance of Pressure Input Fidelity for Multizone Building Models

Sensitivity analysis of the air quality model INCA-Indoor using automatic differentiation
866 F. Guo*, N. Blond, I. Charpentier, M. Mendez, J.-L. Ponche, D. Hauglustaine

Localized bed ventilation for reduced exposure to airborne cross-infection from exhaled air in a double-bed hospital room with displacement background ventilation
916 Z. Bolashikov*, K. Kostadinov, A. Krikor Melikov

Numerical methods for state-space multizone contaminant transport
922 S. Parker*, M. Sohn, D. Lorenzetti
**ID130 Microbiome environment interactions - S. Miller**

Monitoring airborne microorganisms – An important parameter in air infection control of Hospitals and Intensive Care Units  
263  B. Wessén*, P. Frändberg

Comparison of resistance improvement to fungal growth on paints by nano-metal impregnation  
335  C.-C. Lin*, W.-Y. Chen, G.-C. Yao, Y.-C. Lin

**Home Maintenance and Indoor Dampness**  
398  P. Taptiklis*

Effects of indoor air temperature, relative humidity and home dampness on airborne fungi in 454 residences from Shanghai, China  
426  X. Wang*, C. Huang, W. Liu, Z. Zou, R. Lu, L. Shen

Antimicrobial effect of F7 polypropylene fibrous filter containing Zinc pyrithione  
449  Y. Andres*, A. Joubert, L. Le Coq, S. Abd Ali

Mechanisms of bio-aerosol transmission in sanitary plumbing system airflows  
524  M. Gormley*, D. Kelly, T. Aspray

Exploring the rate of surface microbial redevelopment after cleaning in schools; DNA-sequencing and ATP analysis  
1119  S. Kwan, R. Shaughnessy*, U. Haverinen-Shaughnessy, J. Peccia

Hygrothermal performance of ventilated attic in marine climate under different ceiling air tightness  
1141  E. Iffa*, F. Tariku
TUESDAY 09:30 - 10:30  UFO V

ID65 CFD fundamental - Y. Li

Comparing the performance of k-ε turbulence models for isothermal indoor airflow: A case study
218 S. Fu*, P. H. Biwole, C. Mathis

Sensitivity analysis in numerical simulation of indoor airflow: Boundary conditions
236 S. Sadrizadeh*, S.-H. Peng

Comparison and Integration of CFD-based Genetic Algorithm and Adjoint Method for the Inverse Design of Indoor Environment
347 W. Liu*, R. You, Y. Xue, Q. Chen

Numerical simulation of enhanced mass transfer of volatile organic compounds by electrohydrodynamic flow
522 M. Qiang, P. Li, Z. Chen*

Towards real-time immersed boundary lattice Boltzmann CFD simulation tool for transient indoor contaminant dispersion
836 A. Khan*, N. Delbosc, C. Noakes, M.-F. King

Fast Simulation of Chlorine Gas Dispersion in Buildings
1115 W. Tian*, M. Sohn, W. Zuo
TUESDAY 09:30 - 10:30 UFO VI

ID119 Impact of policy, standards, protocols and awareness - C. Bird

Operationalizing indoor air quality monitoring and management protocols across a global technology company's global portfolio
267 L. Riggs*, P. Premchandran, C. Bayer

Reducing Indoor Environmental Risks – the Life Cycle of Safer Buildings
471 C. Bird*, C. Dewar, D. Dillon, J. Dalton, A. Ling

Environmental Monitoring in Contaminated Buildings – Bringing Affordable Science to Safe Outcomes
473 C. Bird*, C. Dewar, D. Dillon, A. Ling, J. Dalton, G. Whiteley

Demonstration project of the IAQ Certification Scheme for Public Use Facilities in Korea
593 S. Sook Kim*, M. Sung

The Development of Risk index algorithm which is applied to chemical accident behaviour analysis/damage prediction models and environmental risk map technology
735 D.-C. Yoo*, J.-R. Sohn, I. Nam, H.-j. Oh

Estimating Current and Future Indoor Air Pollution and Temperatures in England

Effects of Green Mark on indoor environmental quality, occupant satisfaction, health and productivity based on the same cohort moving from a non-Green Mark-rated office to a Green Mark Platinum-rated office in Singapore: A case study
820 K. Wai Tham*, P. L. Wargocki, J. Young Lee, C. Lim, K. Wee Ng, et al.

Self Inspection IAQ techniques for contruction
900 B. Szymanski*, O. Le Mauguen

Why and how to promote greenery inside buildings
1073 I. Oberti*, F. Plantamura

Evaluation of Policy Influence on Long-term Indoor Air Quality in Emperor Qin’s Terra-cotta Museum, China
1179 T. Hu*
ID111 Particles and new pollutants - H. Sagheby

Deposition Removal of Submicron Particles by the aim of a Negative Air Ionizer—the effect of dielectric constant
294 H. Shih, Y.-Y. Wu, Y.-C. Chen, K.-P. Yu*

Semi-volatile organic compounds in indoor settled and HVAC filter dust: seasonal variance and association with building characteristics

Study of Acoustics Induced Deposition of Polydispersed Particles in an Acoustic Aerosol Removal System
446 W. Tung Yuen, H. Him Lee*, S.C. Fu, C. Chao

The Influence of Particle Size on Particle/Air Partitioning of Phthalates
617 K. O’Connor*, K. De Boer, J. Benning

Determinations of Bisphenol A in Household Dusts by Solid-Phase Microextraction with Microwave Assisted Extraction
682 S.-W. Tsai*, C.-W. Chang, C.-J. Chang

Synthetic fibers in indoor air and settled dust: A first overview
729 J. Gasperi*, R. Dris, C. Mirande, C. Mandin, V. Langlois, B. Tassin

Concentrations of new flame retardants in house dust from Japan
754 Q. Wang*, H. Nakayama, Y. Miyake, T. Amagai, K. Kume

Dimensional Study of the Downward Dispersion of Gases due to Density Differences
944 H. Sagheby*, B. Müller, M. Kriegel

Multiple occurrence of particle-bound semi-volatile organic compounds in dwellings
961 O. Ramalho*, F. Mercier, O. Blanchard, M. Pelletier, W. Wei, B. Le Bot, P. Glorennec, C. Mandin
**TUESDAY 09:30 - 10:30 UFO VIII**

**ID84 High school university** - A. Novoselac

Evaluation of temperature based closing criteria at natural ventilation in schools by simulating thermal comfort, energy consumption and CO2-concentration

109  S. Schmidt*, A. Mayer, R. Göttig

Managed airing behavior and the effect on pupil perceptions and indoor climate in classrooms

500  J. Toftum*, M. Wohlgemuth, U. Christensen, G. Bekö, G. H. Clausen

Monitoring of indoor air pollution in classroom - case study

542  S. Vilcekova*, E. K. Burdova, L. Meciarova, A. Estokova

**Carbon dioxide as indoor air quality indicator in renovated schools in Latvia**

841  A. Klavina*, I. Martinsone

**Spatial and Temporal Particulate Matter Variation in Central, Texas High Schools**

882  A. Novoselac*, L. Lesnick, N. Crain, R. Corsi, M. Wade

**Indoor Environment in Schools: Comparing conventional and high performance schools**


**The indoor VOCs concentration, characteristics and source analysis in a new university campus**

988  J. Kang, P. Jing*, J. Liu

**Oxygenated Volatile Organic Compounds (OVOCs) in High Schools**


**Comparison between measured and modelled HOx concentrations in a classroom**

1076  M. Mendez, D. Amedro, N. Blond, D. Hauglustaine, P. Blondeau, C. Afif, C. Fittschen, C. Schoemaeker*
2.3 Morning presentations
| 11:00-12:30
| PLA C-K
ID126 Exposure pathways - R. Shaughnessy

Re-ingestion of pollutants in the building environment: a review of computational approaches
271 M. Chavez*, T. Stathopoulos, A. Bahloul

A comparative study of nebuliser type in the assessment of secondary inhalation of medical aerosols
455 M. Byrne*, R. MacLoughlin, J. McGrath, A. O Sullivan, P. Power

Numerical Prediction of Airway Tissue Dosimetry using PBPK-CFD Hybrid Model integrated into Computer Simulated Person
698 S.-J. Yoo*, K. Ito

Developing the exposure factors for the Korean Children population

Human exposure to semi-volatile organic compounds (SVOCs) via dust ingestion: a review of influencing factors
853 G. Raffy*, F. Mercier, P. Glorennec, C. Mandin, B. Le Bot
**ID12 New directions in Indoor Air Chemistry: the Role of Oxidation Processes - N. Carslaw, C. Schoemaeccker**

The session is focused on IAC and in particular, the ways in which we study the processes involved through laboratory and chamber experiments, measurements in real and experimental buildings and with detailed models.

Now is an exciting time for IAC research with innovative methods being increasingly used. Measurement techniques developed for outdoors are now more commonly used indoors (e.g. recent measurements of radical species), ‘test’ houses are becoming both more numerous and also more relevant to real building conditions and models are incorporating more detail based on these innovations.

Indoor oxidation: which process dominates chemical processing indoors?  
133  N. Carslaw*

Direct measurements of the spectrally resolved solar actinic flux within indoor environment  
870  A. Gandolfo, V. Bartolomei, M. Gomez-Alvarez, S. Tlili, H. Wortham, J. Kleffmann, S. Gligorovski*

Secondary intake fraction (sIF) framework for products generated by cleaning: Example of secondary organic aerosol (SOA) due to terpene ozonolysis  
960  Y. Yang*, M. Waring

Household products and indoor air quality: emission, reactivity and by-products in both gaseous and particulate phases  

Oxidants behaviour in a low energy consumption building with mechanical ventilation  
1077  M. Blocquet, M. Ward, M. Verriele, S. Dusanter, S. Le Calve, B. Hanoune, L. Pillier, N. Locoge, C. Fittschen, C. Schoemaeccker*
Ventilation is a major determinant of public health and energy use. From studies in Sweden (Bornehag et al., 2005) it is shown that a reduced ventilation rate in homes is a major risk factor for allergies among children. In a study of students in Tianjin University it is shown that the lower the ventilation rate in dormitories, the more allergies and infectious diseases are reported by the students (Sun et al., 2011). In cold climate it is shown that the less ventilation, the more infestation of House Dust Mites (HdM) in beds (Sundell et al., 1995). HdM is a main trigger of allergic responses. A low ventilation rate also increases the indoor concentration of pollutants from indoor sources, like formaldehyde, VOCs and SVOCs. Some of such compounds are endocrine disruptors influencing our hormonal system, and now believed to be the cause of “Modern Diseases” like asthma, allergies, diabetes, obesity, reduced sperm quality, male reproductive disorders, and neurodevelopmental disorders like ADHD, and autism (Colborn et al., 1997).

On the other hand, with development of urbanization, energy consumption for heating and air cooling system has a trend of increase. Higher ventilation means higher consumption of energy (unless heat recovery systems are used).

On-site evaluation of ventilation strategies in air-conditioned residential buildings
182 Z. Ai*, C. Mak

Associations between air change rate of the child’s bedroom during night and childhood asthma in Shanghai, China: A case-control study
257 W. Liu*

Ventilation rate in homes in Tianjin, China
884 Y. Sun*

Discussion
This colloquium will explore the concept of beneficial microbial communities in the built environment with a focus on how buildings and the indoor environment mediates human exposure and shapes the human microbiome. It will also examine the effectiveness of building interventions to remediate undesirable microbial conditions within the built environment. As medical research improves our understanding of which microbes or microbial community characteristics are associated with positive and negative health outcomes, there is limited information on how buildings (operating characteristics, design, indoor exposure routes) and human occupants (e.g., person-to-person and building-to-person transmission) influence the human microbiome and can promote exposure to microbes beneficial to health.

Impact of ventilation and cleaning on the microbiology of the build environment in tribal homes: Study design and initial baseline data

1116 R. Shaughnessy*, S. Kwan, U. Haverinen-Shaughnessy, J. Peccia

Towards energy efficient and healthy buildings: an overview how (not) to get a Legionella Pneumophila infection

592 E. Van Kenhove*, J. Laverge, A. Janssens

Indoor Bacterial and Fungal Communities Experience Growth in House Dust at Elevated Relative Humidity

642 K. Dannemiller*, C. Weschler, J. Peccia

Effect of Ventilation on the Microbiome inside Portable Classrooms

969 K. Kinney*, J. Maestre, A. Novoselac, M. King, W. Jennings, S. Bourne, R. Corsi

Farm-like indoor microbiome: Towards asthma prevention

Differences can occur due to the large number of modeling choices that need to be made when using CFD; e.g. choice for a turbulence model, discretization schemes, convergence criteria, etc. All these choices will affect the outcome of CFD studies and can lead to large differences in results. In this session we want to assess and discuss:

1. How to select a good prediction procedure (turbulence models, grid, boundary conditions, ...) to obtain CFD solutions in a strongly non-isothermal situation?

2. How large the spread in CFD prediction results can be for a simple non-isothermal room airflow? methodology

3. How we can limit differences in CFD predictions?

A recent workshop presented at the COBEE/ISHVAC2015 conference in China showed that for an isothermal case large differences are present in the results predicted by a number of experienced and well-trained CFD users. We hypothesize that the major sources of the differences are due to the different decisions of the users. Two major recommendations are made to minimize the user-dependent solutions.

1. **Recommendation 1** - We recommend the users to follow well-documented CFD guidelines in performing such simulations.

2. **Recommendation 2** - We recommend the users to perform the same simulation of a particular case at least 3 times, i.e. treating CFD simulations as CFD "experiments".

As a follow-up of the workshop for isothermal flows at the COBEE/ISHVAC conference, we like to propose a related non-isothermal CFD problem for a simple enclosure. Again no benchmark or experimental data is available for comparison. Finally, the results of performed CFD simulations for this specific case will be presented and discussed during the workshop. A subdivision will be made between the results of users who did and did not follow these recommendations.

**Discussion**
ID37 Workshop: Incorporating design for high perceived control into the design process - R. T. Hellwig

Perceived control in indoor environments has been identified as playing a major role in the perception of the indoor environment. Researchers agree that a high perceived control does positively contribute to satisfaction of occupants. Although the mechanisms behind the term perceived control have not been fully understood in any detail, there seems to be a need to bring the knowledge already available into practice. In recent years the prevalence of building automation systems has been increasing in many buildings. "Net plus energy buildings" or "smart buildings" are supposed to make extensive use of automated control. In designing such highly automated buildings technics exited engineers aim to optimise e.g. the use of renewable energy on-site or store renewable heat in buildings thereby affecting the indoor environment. With the wider application of such buildings the typical user will transform from an enthusiastic pilot occupant towards an ordinary occupant who may tend to be less tolerant of unwanted control events. The more important is that our design process includes the conscious development of controls for indoor environmental application: e.g. their functioning, their control ranges, their responsiveness. The aim of the session is to identify the gap between current knowledge on perceived control already available as a result of research studies and the practical implementation of this knowledge. The main objective of this workshop is to identify supportive measures for the incorporation of high perceived control as a design goal. The audience is expected to report on the design process in their country and whether it already incorporates design towards a high perceived control.

Introduction
R. T. Hellwig, A. Boerstra

Summary of the available knowledge on perceived control
A. Boerstra

Study on the adaptive control of indoor environment in the hot-humid area of China
Y. Zhang*, J. Mai, F. Wang, Y. Zhai, M. Zhang

Conceptual Approach to perceived control and it’s importance for occupant satisfaction
R. T Hellwig
Indoor thermal environment and energy of residential buildings in winter in Lanzhou, China

J. Li, J. Zhang*

Discussion
ID1198 Determining SVOC Emission Parameters from Building Materials - D. Poppendieck

Measurement of emissions of semi-volatile organic compounds from products at elevated temperature using μ-CTE thermal extractor followed by thermal desorption GC/MS

J. Zhu*, M. Nicolas, P. Thiry, Y. Li, F. Maupetit

Field Measurements of PCB emissions from Building Surfaces Using a New Portable Emission Test Cell

N. Lyng*, R. Haven, L. Gunnarsen

Novel SPME method for measuring the characteristic parameter controlling emissions of SVOCs from materials and products

X. Zhang, J. Cao, J. Little, Y. Zhang*

Investigation of particle mediated gas phase transport of phthalates

J. Little*, Y. Wu, C. Liu, E. Vejerano, L. Marr, M. Xie

A simple method to measure the gas-phase SVOC concentration adjacent to a material surface

Y. Wu*, J. Little, L. Marr, M. Xie, S. Cox

Development of an innovative tool for on-site measurement of semi-volatile organic compounds’ emissions from materials

M. Ghislain*, J. Beigbeder, H. Plaisance, V. Desauziers
ID1200 The next steps in school IAQ - F. van Dijken

For this session papers are selected that not only describe the scale and the scope of the problems in schools, but also give an outlook on improving the indoor air quality in classrooms. Key words in the process of improving the situation in school buildings are awareness, quality assurance, maintenance, decision making and policy.

Performance of mechanical ventilation systems in primary schools in Rotterdam, The Netherlands
70 F. Van Dijken*, A. Gelderblom

Indoor air quality in Portuguese primary schools during the heating season: a follow-up study

Preventing indoor air problems in public-private partnership (PPP) schools - Cleaning perspective
660 L. Kakko*, R. Holopainen, M. Leppänen

A Transformational Approach to the Global Problem of Poor Classroom Acoustics
822 P. Juneja*

Indoor environment quality in kindergartens and primary schools in the province of Luxembourg in Belgium
923 M. Kuske, P. Deckers, C. Manette, F. Lacroix, F. De Ceulaer

Analysis of Carbon Dioxide Concentrations and Relative Potential for Airborne Infectious Disease Transmission in 30 High School Classrooms
1089 L. Lesnick*, M. Wade, N. Crain, R. Corsi, A. Novoselac
2.4 Afternoon presentations
| 14:00-15:30
| PLA C-K
ID55 The adsorption type air cleaner VS the advanced oxidation type one such as PCO to reduce the room ventilation rate - A. Afshari

Introduction
A. Afshari

The present and future test & evaluation method of room air cleaners
A. Nozaki

Evaluation of decomposition air purifying technologies for VOC’s
T. Tanaka

The by-products from photocatalytic oxidation of indoor toluene
J. Mo

Gas phase advanced oxidation for indoor air purification
M. Johnson

Discussion
ID13 What can we learn from indoor pollutants modeling?
- C. Schoemaecker, N. Carslaw, N. Blond

IAQ is determined by a number of different processes (e.g. emissions, chemical processes, and transport from outdoors and in/between the rooms). This session will focus on the characterization of pollutant concentrations indoors through the use of different type of models or approaches. Some models focus on one of these processes while others couple different processes. The program includes models driven by emissions, statistical models, 0D models including detailed chemistry and those with complex airflow dynamics with little or no chemistry.

The session will end with a discussion, which will be based on the optimal approach for future development of IAQ models: could the different type of models be combined to produce a holistic IAQ model that considers all of these processes, or is it better to use separate models that focus on particular aspects of the problem, such as chemistry, air flow etc.?

Introduction to the session and to different types of models

A new approach to predict gas-phase concentration of semi-volatile organic compounds from airborne particles: an application to French nationwide survey
464 W. Wei*, C. Mandin, O. Blanchard, F. Mercier, M. Pelletier, B. Le Bot, P. Glorennec, O. Ramalho

Analysis of oxidation processes in indoor air using the time-resolved INCA-Indoor model
852 N. Blond*, M. Mendez, P. Blondeau, C. Schoemaecker, D. Hauglustaine

Understanding the ingress of transient outdoor contaminants into multizone buildings - a state-space approach
924 B. Lingard*, S. Parker

Forecasting of Indoor Air Quality Parameters
1093 L. Morawska*, L. Falcão, S. Clifford, D. Broday, M. Mazaheri

Discussion
TUESDAY  14:00 - 15:30  PLA F

ID2004 Natural ventilation - J. Zhang

Passive enhancement of natural ventilation induced by solar chimney
657  C. Lei*, R. Khanal, T. Wang, L. Thepolaan

Natural ventilation in rural Chinese homes: estimating air exchange rates from real-time PM2.5 concentrations

Ventilation concepts for energy efficient housing in Central European climate - A simulation study comparing IAQ, mold risk and ventilation losses
770  G. Rojas*, R. Pfluger, W. Feist

Investigation of the impact of urban wind-flow on unsteady wind-driven natural ventilation
953  C. Halios*, H. Gough, J. Barlow, C. Noakes, M.-F. King
There is an increasingly request to assess the risk and monitor the health status of workers in modern office buildings. This symposia is promoted by the Scientific Committee on Indoor Air Quality and Health of the International Commission on Occupational Health (ICOH) and the topic will be discussed by researchers of projects performed in modern offices. Modern office buildings are built with the use of new components, materials, equipment, and together with the use of consumer products and the outdoor air reflect the indoor air quality (IAQ); furthermore, the emitted pollutants from office equipment (ozone, primary VOCs, and particles) and secondary VOCs derived from reactive indoor air chemistry are of concern. The exposure load is a variety of chemical, physical, biological, ergonomic, and psychosocial hazards with a potentially high and diversified impact of work-related health problems. An integrated team approach and management is recommended for periodical risk assessment and specific indoor problem solving, through an integration of building assessment, questionnaire survey, and environmental measurements.

**Volatile organic compounds in office buildings: identification of major sources and intervention study to reduce indoor concentrations**
C. Mandin

**Health effects of Indoor Air Quality in European modern office buildings**
P. Carrer

**Physicochemical risk factors for building-related symptoms: thermal conditions and combined exposures to indoor air pollutants**
K. Azuma*, K. Ikeda, N. Kagi, Y. U, H. Osawa

**Why eye symptoms in aircraft and offices?**
P. Wolkoff*

**Indoor air quality audit management in modern office buildings**
J. Bartzis

**Discussion and conclusions**
The complexity of indoor airflow makes experimental investigation very challenging and expensive. With the recent advance in computer technologies, the computational fluid dynamics (CFD) technique has become a powerful alternate for predicting airflows in enclosed environments. CFD can predict and calculate various air distribution parameters and offers richer details, a higher degree of flexibility with lower cost compare to the experimental studies. In this workshop, three short presentations will provide the basis for the discussion regarding the performance of CFD simulations and related in the indoor environmental fields. The focus will be mostly on the particle and contaminant simulation in indoor environments. Validation of CFD simulations will be discussed as well. Questions include when and how Lagrangian and Eulerian particle tracking methods should be applied? What boundary condition should be assigned for particle simulation? What are the most effective steps we should take for CFD validations?

**CFD Modeling of Airborne Transmission in Indoor Environments: Prospective and Retrospective Approaches**

100 C. Chao, SC. Fu*

**On the boundary conditions of numerical particle simulation in indoor environment**

456 S. Sadrizadeh*, A. Ploskić

**Identification of indoor instantaneous airborne contaminant source under dynamic airflow**

588 H. Wang*, S. Lu, J. Zhai

**Impacts of Modeling Simplifications on Predicted Dispersion of Human Expiratory Droplets**

600 L. Liu*, P. Nielsen, C. Xu, J. Wei, Y. Li
The lack of interaction between those working in building energy and indoor air quality trenches is underscored by a recent detailed literature. But if one looks closely at possible bridges between the two trenches there are numerous hidden connections. For example, weatherization retrofits and processes can be sources of flame retardants and other indoor air pollutants. Reduced infiltration and increased insulation can dramatically change thermal gradient and air flow patterns in buildings that affect indoor air quality, including chemical reactions and microbiology. Changes in thermostat settings and dynamic responses to interior space occupation can lead to significant changes in temperature, and relative and absolute humidity, which can change material off-gassing of a range of pollutants. The nature of windows selected for solar heat gain (or lack of gain) can have a dramatic impact on off-gassing of SVOCs in direct sunlight. This session will involve a series of cutting-edge presentations that illustrate connections between building energy use and indoor air quality, and will conclude with an audience discussion of major research needs in this area.

**Introduction**
R. Corsi

**Microbial concentrations of insulation material samples taken from outer wall structures**
301  
P. Markkanen*, H. Karhu, T. Mielo, P. Lönnblad

**Indoor air quality improvement and energy cost of central ventilation air cleaning systems**
567  

**Indoor Air Quality in Weatherized Homes**
855  
P. Francisco*, S. Pigg, D. Cautley, B. Tonn

**Discussion**
Building materials, consumer products and furnishings contain a vast array of chemicals that are emitted to indoor environments where people spend most of their time. Among diverse chemicals found indoors, SVOCs constitute an important class that includes phthalate esters, organophosphate and brominated flame retardants, nonionic surfactants, and pesticides. Many SVOCs are high production volume chemicals used in plastics, detergents, furniture, and other household and consumer products, making them ubiquitous in indoor environments. Additionally, SVOCs persist for long periods, even after the primary source is removed. Despite the serious health concerns, effective strategies to limit exposure to SVOCs remain hamstrung by our poor understanding of their sources and fate in indoor environments. The University of Texas at Austin, Virginia Tech, University of Toronto, and Rutgers University have been working on SVOC emissions, fate and transport, and indoor exposures via chamber tests, field measurements, and modeling analysis. These studies provided valuable information about the emission characteristics of SVOCs and improved our mechanistic understanding of the transport and exposures related to SVOCs in indoor environments.

**A Simple Method for Measuring Gas-phase SVOC Concentration in Equilibrium with The Material Phase**

J. Little Sun

**A SPME-based method for rapidly and accurately measuring the characteristic parameter for emissions from phthalate source materials**

Y. Zhang Sun

**Fate and Transport of Phthalates in Indoor Environments and the Influence of Temperature: A Case Study in a Test House**

Y. Xu Sun

**Measurement of Phthalates in Skin Wipes: Estimating Exposure from Dermal Absorption**

C. Weschler Sun

Discussion
ID36 Infectious Diseases and Indoor Microorganisms in Low Income Settings - C. Noakes, J. Peccia, M.-F. King

The relationship between building design and infection risk is a growing research area. However, although the burden of disease is greatest in low and middle income settings and human health outcomes are known to be related to household income and the development status or income of a country, the majority of indoor air studies focus on developed countries. With the exception of possibly TB, infection transmission studies tend to explore commercial and hospital buildings in developed countries and investigate the performance of high tech ventilation and air cleaning solutions. This colloquium will explore microbial exposures and risks in low income settings. This includes infectious disease, allergic disease and asthma. Low income settings has not been a traditional focus area of ISIAQ, although morbidity and mortality from indoor microbial exposures is significant in these communities and countries, asthma occurrence is now growing in urban and peri-urban centers, and most of these exposure likely occur indoors.

Associations of home characteristics with levels of ergosterol and endotoxin in bed dust in low-income multi-family housing

Impact of water damage on microbial communities in residential buildings

Assessing the role of UK buildings on the transmission of tuberculosis
962 H. Altamirano-Medina*

Home Microbiome and Childhood Asthma in Low Income Rural Homes

Investigating the impact of architectural planning and functional program on the indoor microbiome. A health concern
1121 J. Nice*
2.5 Afternoon posters
| 16:00-17:00
| UFO I-VIII
TUESDAY  16:00 - 17:00  UFO I

ID108 Air cleaners - M. Hernandez

Durability of HCHO Removal Efficiency of Air Cleaner with Plasma Discharger
139    T. Tanaka*, K. Kagawa, A. Nozaki, Y. Narita

Ionic Liquids for the Purification of Air Intakes for Military Applications
354    E. Biddinger*

Removal of carbon dioxide in indoor environment with sorption-type air filters
415    A. Shiue*, S.-C. Hu

Measurement of the Effectiveness of Air Cleaner for Particle Removal
448    S. Zhang*

Application of carbon nano tubes (CNTs) in ozone removal: A pilot study
509    Q. Feng, S. Yang, X. Yang*

Granulation of Growth Media for Indoor Air Purification Utilizing Botanically-Based Systems
572    A. Aydogan Akseli*, G. Tardos, E. Biddinger

Life-Time Performance of Gas Phase Air Cleaners and the Effect of Filter Combination Design
613    L. Zhao*, P. Jing, J. Liu

Effects of Ultraviolet Germicidal Irradiation on Reducing Air-side Pressure Drop for a Cooling Coil in a Hot and Humid Climate
670    Y. Wang*, C. Sekhar, W. Bahnfleth, D. Kok Wai Cheong

Performance evaluation of humidity control and VOC removal of foliage plants by desiccator experiments
695    S. Sakuma*, H. Matsumoto

Decentralized air purification by use of hydrogen peroxide vapor (HPV)
903    F. Pfender*

Evaluation of the performance of VOC-removing air cleaning technologies operated in a modern California detached house
Biofiltration of indoor pollutants by ornamental plants

1163  V. Hörmann*, K.-R. Brenske, C. Ulrichs
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Detection of VOC released from wood-based panels by using a new rapid test method  
84  J. Shen*, W. Liu, C. Du

Development of a reproducibly emitting reference material for volatile organic compounds  

Variable ventilation rate method: Rapid measurement of the key parameters of SVOC emission from indoor materials  
220  J. Xiong*, B. Xu, J. Cao, Y. Zhang

Quantifying formaldehyde emissions from indoor products: Impact and consequences of the MBTH derivatization method  

Characterization of VOC and formaldehyde emissions from furniture products: test chamber measurement and real indoor emission  
445  M.-L. Roux*, M. Nicolas, C. Yrieix, F. Maupetit

Characterizing a formaldehyde reference source for validation of emission test chambers  
552  R. Giesen*, T. Schripp, T. Salthammer

**Fully Automated, On-line Micro-Scale Chamber Method for determination of Volatile Organic Compound (VOC) emissions from Building Products**  
760  I. Mayer, Y. Nie*

Measurements of emissions of low molecular weight compounds from poly (vinyl chloride) sheets with the passive flux sampler method  
813  M. Noguchi*, A. Yamasaki

Dynamic generation facility for the calibration and verification of VOC and semi-VOC equipment in emission testing  
860  A. Baldan*, D. Heikens
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<td>Configuration of ventilation systems</td>
<td>A. Persily</td>
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<td>A guide for renovation solution types of ventilation and building</td>
<td>T. Kalamees*, M. Thalfeldt, M. Zelenski, H. Meos, M. Laas, J. Kurnitski,</td>
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<td>envelopes of typical post WWII apartment buildings</td>
<td>K. Kuusk</td>
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<td>Ventilation effectiveness of residential ventilation systems</td>
<td>M. R. Adili*, M. Schmidt</td>
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<td>Visual assessment of contaminant dispersion and impacts in multizone</td>
<td>S. Parker*, S. Williamson</td>
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<td>Impacts of a solar ventilation unit on temperature and ventilation rate</td>
<td>Y. Wang*, M. Boulic, R. Phipps, M. Plagmann, C. Cunningham, C.</td>
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<td>in New Zealand schools: an intervention study</td>
<td>Theobald, P. Howden-Chapman, M. Baker</td>
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<td>Evaluation of single-sided natural ventilation using a simplified and</td>
<td>C. Plesner*, T. Larsen, V. Leprince</td>
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<td>Effect of angle and location of eaves on the upward cross-ventilation</td>
<td>J. Peren*, T. van Hooff, B. Leite, B. Blocken</td>
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<td>of double-span leeward sawtooth roof buildings</td>
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<td>A new analytical solar chimney model</td>
<td>G. He*, J. J. Zhang</td>
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TUESDAY 16:00 - 17:00  UFO IV

ID91 IAQ subway/train - P. Babu

Health Risk Assessment and Personal Exposures to VOCs in Metro Carriages of Shanghai, China
86 Y. Gong*, Y. Wei, J. Cheng, T. Jiang, L. Chen, B. Xu

Estimation Method of Cooling Load due to Train Wind in an Underground Station

The effect of ventilation protocols on subway air quality
172 T. Moreno*, C. Reche, V. Martins, MC. Minguillón, M. Capdevila, E. de Miguel, S. Centelles, X. Querol

Evaluation of energy consumption and indoor air quality of Sapporo underground walkway in the cold region, Japan
275 Y. Kang*, K. Nagano

Simulation of CO2 Concentration in a Subway during Close Mode Operation
558 Y. Wang*

Experimental analysis of displacement ventilation for the next generation high-speed train (NGT)
799 D. Schmeling*, A. Volkmann, J. Bosbach

Characteristics of particle concentration and wind speed underneath a train cabin in an urban railway tunnel
856 G.-N. Bae*, J. Bum Kim

Numerical Simulation of Airflow at Platform of an Underground Metro Station in Delhi City, India
949 P. Babu*, M. Khare, R. Goyal

Optimal ventilation and filtration strategies for indoor air quality in metro carriages
997 P. Blondeau*, M. Abadie
TUESDAY 16:00 - 17:00 UFO V

ID64 CFD ventilation - T. Van Hooff

A numerical study of non-isothermal mixing ventilation in an enclosure to evaluate RANS turbulence model performance
107 K. Kosutova*, B. Blocken, T. van Hooff

Numerical simulation of cross-ventilation flow: RANS model validation
142 T. Van Hooff*, B. Blocken, Y. Tominaga

Comparison of Volatile Organic Compound Concentration with the Local Mean Age of Air in Ventilated Chamber
517 D. Y. Park*, S. Chang

Dynamic downscaling analysis of air quality from urban to human scale: Part 1 Integration of WRF and CFD to predict wind pressure coefficient
722 Y. Sano*, A. Murga, K Ito, Y. Kawamoto

CFD analysis on wind-driven cross natural ventilation in building of different building length
793 Q. Wang*, Y. Guan, Q. Lu

Integrated CFD and hygrothermal transfer analysis in energy recovery ventilator
1054 Y. Morinaga*, H. Sotokawa, K. Kameishi, K. Ito
TUESDAY  16:00 - 17:00  UFO VI

ID106 Thermal comfort performance of HVAC - S.-I. Tanabe

A Simulation-based Case Study for an Integrated Comfort Control with VRF and Ventilation Systems in Cooling Season
420  S. Ho Kim, J. Won Kim, H. Jun Moon*

A method proposed to determine operating parameters of radiant ceiling terminal
421  Y. Yuan*, X. Zhang, X. Zhou

Individually controlled localized chilled beam in conjunction with chilled ceiling: Part 2 – Human response

Individually controlled localized chilled beam in conjunction with chilled ceiling: Part 1 – Physical environment

The effects of changing air conditioning operation and working conditions on energy consumption in a suburban office

Field Investigation of An Occupancy-Based Climate Control Technology: IEQ Performance during the Cooling Season
495  H. Kim*, E. Oldham, J. Haberl

Study on the thermal environment of the room equipped with porous ceiling air-conditioning system
606  H. Wang*, C. Zhang, H. Zhu, D. Li

Investigation of the Radiation/Convection Combination Air Conditioning System Performance
667  Y. Miyasaka*, T. Akimoto

Study of fluctuating period and airflow distance on human thermal response in a sinusoidal airflow personalized ventilation system
692  Y. Xie, S.C. Fu*, C. Wu, C. Chao

Thermal performance evaluation of Macro-packed phase change materials (MPPCM) under heat boundary conditions
701  S. Kim, S. Jin Chang*, S. Wi, S.-G. Jeong

112
ID83 Kindergarten - D. Rim

Multiple exposures in public kindergartens in dependence of building characteristics – Cologne Program Active Health Care
342 C. Greven*, C. Kaesler, G. Barth, G. Wiesmüller, W. Dott

Indoor Air Problems in New Schools and Daycare centers

Investigation of Indoor Radon Concentrations in Child-care Facilities in South Korea
693 C. Lee*, D. Lee, Y. Cho, Y. Jin, Y. Gwak

Characterization of Indoor Air Pollutants in Singapore Child Care Centres in Different Ventilation Modes
740 B. Wang*, V. W.-C. Chang

Evaluation of indoor air quality in schools and nurseries following odors or symptoms
767 G. Thiault, L. Paillat*, E. Faure, F. Rieunier, G. Goupil, L. Durupt, V. Eudes

Environmental bacterial antibiotic resistance genes in floor dust in a Norwegian kindergarten
1024 A. Nygaard*, C. Charnock

A Study on Distribution of PM10 and PM2.5 Concentrations in Daycare Centers, Seoul
TUESDAY 16:00 - 17:00 UFO VIII

ID50 Social houses - S. Snow

Indoor climate in renovated and energy retrofitted social housing
447  H. N. Knudsen*, O. M. Jensen

Investigation of Thermal Environment for Earth Building in Hot-Humid Area of China
688  J. Fang*, M. Tang, P. Song, L. Jiang

Indoor air quality in South Africa: A case study in a small, isolated low-income settlement
947  B. Language*, S. Piketh, R. Burger

Particulate Matter Concentrations in Multi-Unit Social Housing
1011  A. Mahdavi*, D. Haaland, J. Siegel

Weatherization and Indoor Air in Low-Income Single Family Homes in Denver, Colorado: Preliminary Results
1041  S. Miller*, J. Humphrey, P. Shrestha, J. Adgate, E. Root, E. Carlton
2.6 Afternoon keynotes
| 08:30-09:30
| UFO main auditorium
HVAC filters as a novel sampling method for indoor particles
Jeffrey Siegel - University of Toronto

Jeffrey Siegel is engaged in a wide variety of research areas. He is generally interested in understanding the indoor environment and specifically interested in indoor contaminants (especially particles and aerosols), building energy use, the connection between indoor and urban environments, and sustainable buildings. Specific projects are determined by funding, student interests, and overall fit with my research portfolio and workload. He is an experimentalist and primarily conduct field projects with a smaller component of laboratory research. His goal for the next decade is to collaborate with others to build the Canadian academic center for indoor environmental research.

Some estimates are that 80% of our health risk from airborne contaminants comes from particles that are breathed indoors. Given their importance and ubiquity, it is critical that we understand the amount and composition of indoor particles. The HVAC filters that are installed in every forced air conditioning system over an in-situ long-term temporally and spatially integrated sample of indoor particles. By combining physical, chemical, and biological dust extraction techniques with in-situ HVAC system and filter characterization we can assess the exposure to indoor particles of almost any composition. We have successfully demonstrated this technique for fungi and bacteria, phthalates and flame retardants (SVOCs), and heavy metals. Our goal is further develop the technique as a means to understand the indoor environment as well provide guidance to public health decision makers on the spread and nature of indoor contaminants. Ultimately the idea of Filter Forensics is to provide a low-cost approach to understand a broad range of indoor contaminants.

Jeff will link this idea to his ongoing research on filtration, particle and gas-phase contaminant sampling, indoor chemistry, passive (zero-energy) removal of indoor contaminants, ozone generation by air cleaners, portable air cleaners, particle resuspension by human activities, contaminant penetration through building envelopes, radon emissions from concrete, particle-phase indoor reactive oxygen species (ROS) and secondary organic aerosol (SOA) to address the question: “What makes for effective air cleaning?”. 
KEYNOTE 4

Indoor air cleaning: where we are and where to go?
Yinping Zhang - Department of Building Science, Tsinghua University, Beijing, China; Beijing Key Laboratory of Indoor Air Quality Evaluation and Control, Beijing, China

Keywords: Indoor air quality, air cleaning, exposure, health risk, energy efficient

The objective of this lecture is to present a review on indoor air cleaning techniques. From the review, two key problems are identified:

1. How to determine a suitable indoor air cleaning system and optimize its operation;

2. How to evaluate the health benefits of using an indoor air cleaning approach.

The research advances on addressing the two aforementioned problems are introduced:

1. Our recent research advance on inverse problem combined with variation method is introduced;

2. Evaluating the health benefits by monitoring the changes of levels of selected biomarkers.

The pioneering works (such as Jim Zhang et al., 2008, 2016; Haidong Kan et al., 2015) are reviewed and our on-going research co-operated with Jim Zhang and Charlie Weschler is also introduced. Problems needing future research are put forward.

Acknowledgements: Thanks Jim Zhang, Duke University and Charlie Weschler, Rutgers University for leading the co-operation the research with me. Thanks Jinhan Mo, Feng Li et al. for the co-operating research. Thanks for NSFC for financial support (The grant nos. are 51420105010, 51136002).
DAY

3 WEDNESDAY
### Day schedule

#### WEDNESDAY

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**Legend:**

- **T1** Society
- **T2** Chemistry
- **T3** Ventilation/Thermal comfort
- **T4** Health
- **T5** Modelisation
- **T6** Energy/Sustainability/Design
- **T7** Emission
- **T8** Microbiology
- **T9** Specific environments
- **T10** Tools
3.1 Morning keynotes
| 08:30-09:30
| UFO main auditorium
KEYNOTE 1

Stress and dose/response interactions
Jane Clougherty - Departement of Environmental and Occupational Health, University of Pittsburgh, Graduate School of Public Health

Jane Clougherty is an Assistant Professor of Environmental and Occupational Health (EOH), Graduate School of Public Health, University of Pittsburgh. As an interdisciplinary Environmental Health Scientist, her training and experience lie predominantly in air pollution exposure assessment and environmental epidemiology, but her interests also include occupational health, social epidemiology, community-based research, and toxicology.

Her research focuses primarily on the role of chronic social stressors in modifying population susceptibility to air pollution, in both community and occupational settings.

KEYNOTE 2

Sensory perception of the indoor environment
Thomas Hummel - TU-Dresden ENT Clinic

Prof. Dr. med. Thomas Hummel is one of the driving forces behind the unit ‘smell and taste’ at the TU-Dresden ENT Clinic, specialised in both clinical and research work related to disorders of olfactory and taste senses. The unit’s work covers aspects of the trigeminal Chemoreception, differences between ortho and retronasalem smelling and issues of human chemosensation. In addition, another focus - in addition to the work on improved diagnosis and treatment of olfactory disorders – is on studies to affect olfactory and gustatory function in neurodegenerative diseases and in Parkinson's disease.
3.2 Morning posters
| 09:30-10:30 |
| UFO I-VIII |
ID58 Thermal comfort in bedrooms - H. Zhang

Effects of temperature cycles on thermal comfort and sleep quality of sleeping people
160 L. Lan*, Z. Lian

Evaluation of Skylight Sufficiency for Thermal, Light and Visual Environment in KF-Station

Human thermal response for people lying at rest in the environment cooled by fans and air-conditioners
377 Y. Chen*, Y. Zhang

Effects of Fluctuations in the Thermal Environment on Quality of Sleep

Operation of gradated venetian blinds by high school students and daylight utilization

Sensory evaluation of building products: a critical discussion of the overall method
478 T. Salthammer*, E. Uhde, N. Schulz, R. Stolte

The effects of increased bedroom air temperature on sleep and next-day performance
640 S. Petersen*, P. Strøm-Tejsen, S. Mathiasen, M. Bach

The impact of ventilation and daylight on learning in schools – a summary of the actual state of knowledge
761 S. Urlaub, G. Grün*, P. Foldbjerg, K. Sedlbauer

Pilot study on the effect of neutral-hot condition and airflow on sleep quality
796 M. Zhu*

Bedroom thermal satisfaction and AC usage patterns in New York City
1069 W. V. Lee*, J. Shaman

Field survey on indoor thermal environment of bedroom during sleep in Southeast Asia
1070 I. Mori*, K. Tsuzuki
WEDNESDAY 09:30 - 10:30  UFO II

**ID93 IAQ transport** - Z. Luo


Indoor Air Pollution at the Jerusalem Central Bus Station 207 G. Sharf*, D. Alper Simantov, M. Peleg

Effect of urban street canyon on intake fraction for traffic pollutants 246 Z. Luo*, J. Hang

Influence of temperature on dynamic emission of formaldehyde from interior materials in vehicle cabins 312 S. Yang, X. Yang*

Effect of indoor wind on temperature distribution with door opening and closing in an urban transit car during winter season 403 Y. Cho*, S. Bark Kwon, D. Park

Experimental analysis of different ventilation concepts for the passenger compartment of a generic car 515 T. Dehne*, A. Volkmann, D. Schmeling, J. Bosbach

Vehicle Interior Air Quality - (S)VOC Emission from Materials: Regulation, Standard Methods and Analytical Implementation 603 C. Widdowson*

Investigation on deposition effect of roadside trees on traffic released PM10 in street canyon 605 F. Xue*, X. Li

Numerical evaluation of vertical air ventilation systems for future car cabins 659 N. Boughanmi*, L. Enke, J. Frisch, C. van Treeck
WEDNESDAY  09:30 - 10:30  UFO III

**ID133 IAQ surveys and case studies - A. Melikov**

**The risk of indoor air pollutants accumulation in five housing types in Ho Chi Minh City (Vietnam)**


**Typology of houses and ventilation characteristics: a case study in Ho Chi Minh City (Vietnam)**


**Ventilation rates before and after energy retrofit in multi-family buildings in Finland**

V. Leivo*, M. Turunen, A. Aaltonen, M. Kiviste, U. Haverinen-Shaughnessy

**Index for surveys of indoor pollution in Brussels dwellings**

C. Chasseur*, S. Bladt, M. Wanlin

**Field testing of ventilation in large shopping centres in China**

H. Li*, X. Li

**The ISOPA Passive House - Indoor Air Quality Performance**

E. Vangronsveld*, K. Ahrika
WEDNESDAY  09:30 - 10:30  UFO IV

ID61 Preventive health care - S. Benoy

Sick Building Syndrome - standards, current issues and possible solutions
231  C. Croitoru*, I. Nastase

Measuring Environmental Contamination in Patient Rooms and Improving Cleaning Methods

Personal exposue and biological monitoring in assessing environmental exposure to toluene

Laboratory tests of the indoor air filtration efficiency of green walls
945  B. Hanoune*, A. Caron, A. Langlois, M.-A. Cannesan

Occupational Hygiene and Indoor Environmental Quality Technician Walkthrough Tablet-Based Survey for Urban Hospitals
1007  T. Cordon, D. Shendell*, M. London

Indoor particulate matter pollution related to cigarette smoke and its removal effect of air cleaners
1083  A. Nozaki*
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<td>Y. Zhang</td>
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<td>Preparation and antibacterial activity of silver nanoparticles supported by TiO2-chitosan nanocomposites</td>
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<td>M. Hernandez*, A. Handorean, J. Pagan</td>
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<td>T. Yamaguchi*, E. Sumiyoshi, K. Yamamoto, E. Lim, K. Ito</td>
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<td>Long-term Performance Analysis of the Indoor Environment PSBM Using the MEMS Sensing System</td>
<td>C. C. Chen*</td>
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ID104 Thermal comfort performance of HVAC - T. Akimoto

Interaction of thermal radiation with indoor turbulent natural convection heat transfer in rooms with porous building envelope
83 Y. Wang*, J. Yang, X. Zhang, Y. Pan

154 A. Kabanshi*, H. Wigö

Personalized Heating – Heaters’ effectiveness
164 M. Vesely*, P. Molenaar, Y. Zhao, W. Zeiler

Effect of a chair-based personalized isothermal airflow system on thermal comfort
198 S. Watanabe*, J. Ishii

Modeling of a Hybrid Solar Radiant Cooling System in a High-Rise Building in Malaysia
214 Y. H. Yau*, H. Low

Low energy comfort with air movement in sport facilities
237 Y. Zhai*, C. Elsworth, H. Zhang, E. Arens, Y. Zhang, L. Zhao

Thermal Comfort in High-Rise Double Transparent Facade Buildings - facade opening size
262 K. Valouskova*

The Effect of Vertical Greenery with Cross Ventilation on Improving Thermal Comfort
280 M.-C. Lu, W.-C. Chiu, Y.-S. Tsay*

Numerical analysis of thermo-aerulaic behavior for a ventilated enclosure, provided with radiant cooling ceiling
282 C. Teodosiu*, V. Ilie, R. Teodosiu

A Model for Predicting the Evapotranspiration Rate of Wild Allamanda for Living Wall Systems
292 J.-Y. Lin, C.-H. Lin, Y.-S. Tsay*
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<td><strong>Modeling the Impact of Residential HVAC Filtration on Indoor PM2.5 of Outdoor Origin and Associated Long-term Health Impacts for Reducing Premature Mortality</strong></td>
<td>D. Zhao*, B. Stephens, P. Azimi</td>
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<td><strong>Relationship between indoor and outdoor particle concentrations by penetration coefficient and deposition rate in office building</strong></td>
<td>B. Lee*, S. W. Yee, D. H. Kang, M. S. Yeo, K.-W. Kim</td>
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<td><strong>The impact of a portable air cleaner on residential indoor air pollution reductions in China – An intervention study</strong></td>
<td>Q. Meng*, H. Wang, T. Zhang, B. Li, R. Yao, Z. Fan, H. Kipen</td>
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<td><strong>Impact of outdoor pollutions on indoor environments – case study of three primary schools in the UK</strong></td>
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<td><strong>Impact of different structure of external window on indoor air quality with respect to PM2.5 pollution based on infiltration ventilation</strong></td>
<td>Z. Chen*, C. Chen, S. Wei, L. Zhao, Y. Wan, Y. Wang, Y. Wu, K. Gu</td>
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ID98 Microbiology - M. Täubel

Charaterization and Antifungal Performance of Nano-Silver Supported by TiO2 on Aspergillus niger Spores
103  Y.-C. Chen*, K.-P. Yu, M.-C. Tsai

Is low indoor humidity a driver for healthcare-associated infections?
340  S. Taylor MD*, W. Hugentobler

Occurrence of visible moulds in French schools and nurseries
772  O. Ramalho*, J. Ribéron, C. Mandin

Retention of fungal enzyme activity in penicillium, cladosporium, aspergillus and acremonium samples
800  A. Salmela*, V. Lappalainen, P. Pasanen, T. Reponen

External review procedures in Finnish state-supported mold renovations
828  T. Marttila*, P. Annila, J. Suonketo, P. Kero, M. Pentti

Use of indoor air parameters as indicators of water damage in buildings:
Results from a field study of Public and Private housing in New York City
954  M. Spilak*, M. Waring, R. Adams, I. Sylvain

The Microbiome of the Built Environment and Mental Health
3.3 Morning presentations

| 11:00-12:30
| PLA C-K
ID2005 Perception/odors/surveys - T. Salthammer

Transferability of results of olfactory measurements under laboratory conditions and in a field test
140  D. Hegemann*, M. Wesseling, D. Müller

What is your unpleasant odor?
373  A. Hasegawa*, T. Shiiba, M. Mitsuda

Sensory evaluation of building products: influences of direct and indirect assessment
412  T. Salthammer*, E. Uhde, N. Schulz, R. Stolte

Method-Verification and Optimisation of the standardised assessment of Odour Intensity regarding ISO 16000-28
568  L. Brosig*, W. Horn, O. Jann

Comparison of VOC sampling and odour test methods for material testing
918  M. Jönsson*, P.-E. Gustavsson, M. Bude

Sensory ratings of emissions from nontraditional building materials
1107  B. Krejcirikova*, J. Kolarik, R. Peuhkuri, C. Rode, P. L. Wargocki
ID2000 IAQ, ventilation and energy-efficiency in European buildings: advancing the integrated implementation of related new concepts, guidelines, standards and tools - S. Kephalopoulos

The focus of this symposium is the triangulation among exposure, indoor/outdoor sources, energy efficiency and ventilation and its implementation within an EU policy perspective. The aim is to present and discuss the advancement of the integrated implementation of new concepts, guidelines, standards and tools that will enable achieving safe, healthy, energy efficient and sustainable buildings in the European Union via a holistic approach of buildings’ “efficiency”.

The progression towards meeting the targets for high energy efficient buildings in EU by 2020 resulted to a stepwise tightening of minimum energy performance requirements in EU MS. To avoid that this might result in deterioration of indoor air quality (IAQ), comfort and health conditions in the European building stock, measures related to energy sufficiency/efficiency and renewable energy supply should be implemented in an integrated fashion together with appropriate strategies dealing with indoor and outdoor pollution sources, ventilation, thermal comfort, acoustics and lighting. This implies the development of a new concept of approaching holistically the building’s “efficiency” which should be implemented in liaison with proper health-based ventilation guidelines, standards and tools and embedded in well informed policies and actions in order to guarantee the health protection of the buildings’ occupants while rationalising economic and energy expenditure.

Indoor air quality and ventilation in the future world practice

E. de Oliveira Fernandes*, H. Santos, S. Kephalopoulos, P. Carrer, P. L. Wargocki

IAQ, ventilation and energy-efficiency before and after energy retrofits: lessons learned from implementation practices in Northern-Europe

J. Kurnitski*

The Information Platform for Chemical Monitoring in EU (IPCheM)

S. Dalla Costa*, S. Kephalopoulos*

The European Energy Efficiency Platform (E3P)

D. Paci*, I. Maschio

Discussion
ID1112 How can ventilation systems contribute to energy efficient and healthy buildings? An overview of Indoor Air Quality developments in the ventilation sector - C. Haendel

Introduction
J. M. Ramos

The role of Ventilation in Indoor Air Quality
C. Haendel

Occupant perception of mechanical ventilated classrooms in Germany
R. Hellwig

The EVIA Indoor Air Quality Label for Residential Ventilation Systems
Y. Lambert

Discussion
moderated by J. M. Ramos
Valuable local projects in the field of environmental health, and more specifically indoor air quality, have difficulties in getting known in other regions or countries. It is not always easy to identify if a project has value or has to potential to succeed. In this session, we start by introducing the Flemish action week of healthy living. This week aims to improve indoor air quality in Flanders through local actions. Moreover, other speakers will explain their related projects and experiences. There is an urgent need for an international network to enhance and exchange the knowledge and experience of local projects and initiatives to improve indoor air quality. With this session we hope to be able to create the foundations of such a network and gather interested partners who are willing to cooperate.

Preventive health care in practice
S. Benoy

How can you make prevention work? Applied to indoor air quality
A. Verdeyen

Effects of Educational Activity on Opening Control of Windows with a Natural Ventilation Maximization System for School Buildings

Requirements for indoor air in refugee accommodations
C. Hornberg*, G. Wiesmüller, J. Hurraß, A. Bunte

Description and categorization of domestic carbon monoxide poisoning events occurring in the area of Paris and related to the use of equipment connected to individual flue
C. Bassi, G. Goupil, G. Thiault, F. Taurines, A. Verrier

Radon awareness policy in Belgium and stakeholder interactions
B. Dehandschutter

Discussion
Contamination of indoor air by pollutants that are spread from the building materials of a building may cause adverse health effects. Several pollutants are moisture related e.g. molds and mold products, substances formed from degradation of building material components including paint and glue, chloroanisols following microbial degradation of chorophenols used for impregnation, terpenes from wooden materials etc. Other emissions may be unrelated with moisture such as PCB from (previously used) PCB-containing sealants, formaldehyde from various materials, radon from concrete, plasticizers from plastic floorings etc. The emissions may spread into the indoor air from floor, ceiling or walls and result in asthma and other symptoms of the respiratory tract. There are several reasons why it is essential to reduce the emissions. We are spending more and more of our time indoors. Because of age and diseases such as cancer a growing number of individuals in the society are immunocompromised and increasingly sensitive to air pollution.

Reducing the emissions may involve replacement of the affected building materials with new materials, an often effective but also very complicated and costly solution. Alternatively, one may accept the emissions but prevent them from reaching the indoor air. Using an air cleaner placed inside a building for removal of particles or volatile pollutants will reduce the air concentrations of the emissions regardless from where they are spread but will not stop them from reaching the individuals in the building. By contrast, covering the surface from which the emissions are spread with a sealant will stop the emissions at the source. Several exciting new products and methods have been developed recently involving improved ventilated floor solutions and/or innovative sealants.

The session will focus on different methods to reduce emissions that are spread indoors from the building materials of a building. Adequate references from the scientific literature will be given during the session.

Introduction
L. Larsson

A novel solution for reducing the transfer of contaminants among adjacent apartments
A. Iqbal*, A. Afshari
Laboratory test of source encapsulation for decreasing PCB concentrations
284 B. Kolarik*, H. Andersen, P. Markowicz, L. Gunnarsen, L. Larsson

Experiences in Using a Surface Emissions Trap to Improve the Indoor Air Quality by Efficient Exposure Reduction
290 L. Larsson*, J. Mattsson

Longterm Effects from Damaged Floors in Apartments
428 P. Metiainen*, H. Mussalo-Rauhamaa

Efficiency and performance tests of the sorptive building materials that reduce indoor formaldehyde concentrations
844 C. C. Lee*, H. Kun-Chih, C. Jung-Wei, Y.-S. Tsay, C. Che-Ming

Summing up
A. Afshari
There have been several successful examples of IAQ technology transfer. Radon education efforts in the USA have resulted in radon commonly being tested prior to real estate transactions. Knowledge of second hand smoke health impacts have lead to bans on indoor smoking in many indoor facilities throughout the world. Triclosan has been removed from personal care products of a major USA retailer.

However, the general public, policymakers and other stakeholders are largely unaware of the health impacts of indoor air contaminants that has been the subject of much research done by ISIAQ members. The average consumer wants to live in a healthy and comfortable house, and wants the same from their workplace and certainly their children’s classrooms. This is evident by the growing market for home indoor air quality monitoring equipment, with new devices coming to market that are able to measure CO₂, PM, and TVOC. However, most people lack knowledge on their personal IAQ exposures and impacts. Consumers motivated to address indoor air issues often assume that replacing “manufactured chemicals” with “natural” products like essential oils will accomplish the goal of improved IAQ.

ISIAQ has substantial knowledge on primary emissions, secondary reactions, indoor transport, ventilation and the microbiome that the public, policymakers and other stakeholders is not aware of or benefiting from. The objective of this session would be to examine how we convert these IAQ research efforts into impacts in the real world? The goal of this workshop would be to have panel members give short introductions on what we have done to effectively communicate this information to society at large and then invite the audience to have a discussion on the barriers and limitations to further IAQ technology transfers. The idea would be to brainstorm the role that ISIAQ can have on more effectively reaching the general public on how to improve the air they breathe. Given time limitations, the target topics would be on issues related to the developed world IAQ.

Discussion
ID1196 Impact of the outdoor air quality on indoor environments - M. Verriele-Duncianu, N. Nicolas

It’s commonly admitted that indoor sources more contribute to VOC concentrations compared to outdoor ones. But the infiltration rate of particulate matter, ozone, or other gaseous compounds characteristic of outdoor pollution is less documented. We still have very limited information on the penetration factors that govern infiltration. Advances on monitoring devices permitted continuous measurement of these species and allowed a finest determination of the influence of outdoor pollution on indoor air quality. In fact, this influence is indexed on the configuration of the building (isolated building or street canyon) and on its location (related to dominant winds and main pollution sources). Finally, the indoor environment without mechanical ventilation systems, must be well distinguish to new buildings with controlled ventilation; in one hand infiltration is the dominant air exchange path and in the other hand indoor concentrations are clearly influences by ventilation schedules.

Chemical Characterization of indoor and outdoor PM2.5, PM10 and VOCs in a public building in Doha City, Qatar

On-line VOC monitoring in a low energy building: impact of material and occupant activity emissions, outdoor sources and ventilation on ambient concentrations
571 M. Verriele*, T. Leonardis, S. Dusanter, C. Schoemaeccker, N. Locoge

Airtightness and infiltration of fine particulate matter from outdoor of an apartment building in Korea
696 J. Bang, S. Jo, M. Sung*

Determining pollution infiltration rates for a building in a densely packed urban neighbourhood
1016 J. Barlow*, A. Brocklehurst, C. Halios

An experimental study to investigate the impact of outdoor particles on indoor air in residential housing units
1036 D. Hwa Kang*, D. Hee Choi
Analysis of Indoor and Outdoor Ozone Concentrations in 30 High School Classrooms

M. Wade*, L. Lesnick, R. Corsi, A. Novoselac, N. Crain

Discussion
ID22 Assessing moisture and mold in buildings in practice and the role of microbial determinations - R. Shaughnessy

In practice, building investigations for dampness and mold including microbial assessments are carried out in various manners based on guidance afforded by credible sources such as ACGIH, AIHA, ASHRAE, EPA, WHO, etc. The methods utilized by the investigator are founded upon the given exposure, type of building, extent of moisture/mold damage within the space, occupant concerns, and other pertinent considerations. Professional judgment is vital to the process given that each setting may have its own unique challenges to be accounted for. Specifically, the role of microbial assessments in building investigations for moisture damage and indoor mold is an issue that is addressed in a very heterogeneous way by different practitioners in different countries. This is in part due to the fact that if at all, very diverse guidance is provided on national level on that issue, and as a consequence practitioners are little informed and advised. This triggered the STC on Microbes to formulate a document that summarizes basic knowledge on that topic based on scientific evidence and presents an overview of guidance available in various countries throughout the world. Most importantly, it is the aim to formulate an expert recommendation on the Do’s and Don’ts when it comes to microbial determinations in indoor assessments that target moisture and mold. In this workshop the STC will present this document and ask opinion and input on its content from practitioners as well as scientists present in the audience, helping to refine the final document. In addition, we will discuss developments in microbial sampling/analysis based on DNA sequencing and other DNA based methods, and potential uses and limitations that these methods afford to field practitioners.

Introduction
R. Shaughnessy

Building investigations for moisture damage and dampness - the Finnish example: national guidance and a practitioner’s view
A. Hyvärinen, M. Pitkäranta

Considerations of microbial sampling and analyses in damp building investigations
T. Reponen
Emerging knowledge from and applicability of DNA sequencing in damp building investigations; potential uses for practitioners today
K. Dannemiller*, J. Peccia

The role of microbial assessments in building investigations as considered by the ISIAQ Scientific Technical Committee for Microbes
M. Täubel

Discussion
3.4 Afternoon presentations
| 14:00-15:30
| PLA C-K
ID35 Do healthy buildings need technology? - W. Bruijn

While buildings require less and less energy, more and more is being spent on the maintenance and service needed to sustain this reduction. The prospect of buildings functioning as power stations is highly reminiscent of the promises of Modernism. The only disruptive factor in this energy balance from an ideal world, however, is the human element. The architects have no intention of replacing nature with technology in their office block in Lustenau. Their aim is rather to establish meaningful coherence for the user.

The building has no heating, ventilation or cooling system, the flow of energy being controlled automatically or by human hand. Above all, however, this is a stone building with walls, doors and high rooms. It needs little grey energy, and elementary architectural means are used to create a sense of well-being that derives from the pleasant proportions and self-explanatory use.

The envelope has a cavity wall structure with each wall consisting of two layers of 36-centimetre bricks. The inner layer of this interconnected shell ensures high compressive strength while the outer layer guarantees efficient insulation. Deep window reveals reduce the heat input, while vents fastened inside are controlled by sensors to provide a pleasant room climate. In winter, for example, the waste heat ensures a high energy input and the window vents only open if the volume of carbon dioxide in the room increases. During hot weather in summer the vents open at night to induce a draught for natural cooling. Sensors support, in a perhaps less controlled manner, the normal activity of the occupants of a building that in conceptual, aesthetic and everyday terms will retain its validity for a long time to come.

Introduction - Atmosphere without machines
W. Bruijn

The architectural/climatic concept of building 2226 Lustenau, Austria
W. Bruijn

The energetic concept of building 2226, Lustenau, Austria
P. Stefan Widerin

Indoor climate of building 2226, Lustenau, Austria
W. Hugentobler

Discussion
The overall objective of the “Annex 68” Project, which belongs to the International Energy Agency’s Energy in Buildings and Community program, is to develop the basis for optimal design and control strategies for good Indoor Air Quality (IAQ) in highly energy efficient residential buildings, and to disseminate this information in a practically applicable guide. Such strategies should facilitate the possibility to design and operate residential buildings with minimal energy use, while ensuring impeccable indoor climates. The project will gather existing data and provide new knowledge on pollution sources in buildings and their heat, airflow and moisture interactions. Contemporary models will be assembled to simulate the combined heat, air, moisture and pollution conditions of new NZEB’s or energy refurbished existing buildings. The project will identify ways to optimize the provision of ventilation and air-conditioning.

The project is organized into five subtasks:

1. **Subtask 1 - “Defining the Metrics”**, will set up the metrics for the relevant performance parameters, which combine the aspiration for very high energy performance with good indoor air quality.

2. **Subtask 2 - “Pollutant loads in residential buildings”**, is to gather existing knowledge and provide new data on indoor air pollutants in as far as it has relation to thermal, airflow, and moisture conditions in buildings.

3. **Subtask 3 - “Modelling - review, gap analysis and categorization”**, will identify new couplings and use of modelling tools that can enhance our understanding of the combined thermal and mass flow effects under practical circumstances that can assist designers and operators of buildings.

4. **Subtask 4 - “Strategies for design and control of buildings”**, will build upon the previous subtasks to develop a guidebook on design and control strategies for energy efficient ventilation in residential buildings that will be optimized to provide also very good indoor air quality.
Subtask 5 - “Field measurements and case studies”, will identify and gather data from relevant case studies and field measurements where the above-mentioned strategies can be examined and optimized.

The first part of the seminar will be to present the project and its specific subtasks and activities therein, as well as to present the plan for deliverables. A subsequent part will be to discuss the content of the Annex project with the participants and gathering comments from the audience. The discussion shall focus on the expression of decisive metrics for IAQ with a view to implementation in policies, standards, and practice.
ID54 Doing Ventilation Right in IAQ Studies: How to Actually Understand Your Contaminant Measurements - P. Wargocki

The first presentation will lay out the problem of how poorly too many IAQ studies address ventilation, reminding the attendees of the importance of ventilation in understanding indoor pollutant concentrations. As an example, the recent literature search on associations between health effects and ventilation rates will be highlighted. The next presentation will present a range of options for characterizing ventilation system design and for measuring ventilation rates. These options will include simpler, inexpensive approaches appropriate for large field studies, as well as more detailed approaches that are required in other cases. The final presentation will describe the resources available from the Air Infiltration and Ventilation Centre, including publications, bibliographies and summary reports on key topics in the field.

How to Understand Ventilation in a Building
A. Persily

The IAQ Family’s Deep Dark Secret: Poor Ventilation Characterization in IAQ Studies
P. Wargocki

The Great Resources Available from the Air Infiltration and Ventilation Centre
P. Wouters

Discussion
**ID19** Clothing and its impact on exposure to air pollutants in indoor environments - G. Morrison

Dermal uptake of semi-volatile organic compounds from indoor air has recently been shown to be an important exposure pathway. Clothing, as a “second skin”, has the potential to enhance or limit transport from air to skin.

**Role of Clothing in Dermal Exposure to Phthalates: Insights from Sampling both Skin and Jeans**

179 M. Gong*, C. Weschler, Y. Zhang

**Measurements of Dermal Uptake of Nicotine Directly from Air and Clothing**


**Role of clothing in transdermal uptake of gas-phase SVOCs: transient model development and evaluation**

372 J. Cao, Y. Zhang*

**Size-resolved total particle and fluorescent biological aerosol particle emissions from clothing**

656 Y. Tian*, D. Licina, J. A. Huffman, N. Savage, W. Nazaroff

**Dermal uptake of phthalates from clothing: comparison of model to human participant results**

685 G. Morrison*, G. Bekö, C. Weschler

**Experimental approach to determine the SVOC-uptake of different fabric types**

979 E. Uhde*, G. Morrison, T. Schripp, D. Varol
Indoor oxidative chemistry is largely due to reactions of volatile organic compounds (VOC) with the oxidants of ozone, the hydroxyl radical (OH), or the nitrate radical (NO3). Due to the prevalence of indoor terpenes, most indoor chemistry research has focused on ozone + alkene reactions, though a little has focused on the OH generated by those same reactions. Further, NO3, which is generated by ozone reactions with nitrogen dioxide (NO2), has received only limited attention.

However, recent research has demonstrated that this narrow view of indoor oxidative chemistry is not warranted, and that there is a much richer chemical mechanism occurring indoors. For instance, newer work proposes (i) that photochemistry generates OH due to the photolysis of nitrous acid (HONO), which is either emitted by combustion processes or generated by NO2 heterogeneous chemistry; (ii) from a total VOC oxidation standpoint, OH may be just as important as or perhaps even more important than ozone indoors; and (iii) radical chemistry of stabilized Criegee intermediates (SCI) may be an important source of NO3.

Influence of operating parameters on photocatalytic oxidation treatment efficiency: contact time investigation
255 V. Hequet*, L. Olivier, V. M. Mboula, C. Raillard, A. Subrenat, L. Le Coq

Photocatalytic air-purifiers for indoor air: European standard and pilot room experiments
423 S. Lacombe*, N. Costarramone, C. Cantau, V. Desauziers, C. Pecheyran, B. Kartheuser, T. Pigot

Impact of photocatalytic building products on indoor air quality under Visible Light conditions
655 V. Bartolomei, S. Delaby, D. Boutry, M. Nicolas*

Ozone catalytic oxidation of indoor formaldehyde over MnOx-CeO2/TiO2 catalysts prepared by chemical vapor condensation at room temperature: effect of a ceria additive
709 J. Jurng, E.S. Park*

Reactive uptakes of NO2 on photocatalytic paints as a function of temperature
871 A. Gandolfo, S. Gligorovski*, H. Wortham
WEDNESDAY  14:00 - 15:30  PLA I

ID2009 Human emissions  -  W. Nazaroff

Measurements of Dermal and Oral Emissions from Humans
288       S. Tsushima*, G. Bekö, R. Bossi, S.-i. Tanabe, P. L. Wargocki

Personal activities as sources of human personal clouds
276       D. Licina*, Y. Tian, W. Nazaroff

Contributions of Human Emissions to Indoor Air Composition
653       A. Goldstein*, X. Tang, P. Misztal, W. Nazaroff

Characterization of exhaled breath droplets from influenza patients in the tropics
723       K. Wai Tham*, V. Chow, D. Tay

Effects of Exposures to Human Bioeffluents
1113      X. Zhang, P. L. Wargocki*, Z. Lian
**WEDNESDAY** 14:00 - 15:30  \[**PLA J**\]

**ID48** Application and validation of models for whole building indoor-outdoor contaminant transport - M. Sohn

Understanding the movement of air within indoor environments, and exchange with outdoor air, is a key component of understanding the exposure of occupants to outdoor pollutants. While mechanically ventilated buildings may appear to have clear transport paths, the interplay of natural and mechanical ventilation, or changes to ventilation operation can affect the transport of contaminants within a building. Modeling the indoor air movement for different scales of buildings, from small residential structures to multi-unit residential buildings or large complex commercial or institutional buildings, poses unique challenges. When considering air movement within a whole building, the exchange of air with the outdoor environment often becomes a key contribution, through both controlled and uncontrolled air exchange. This session seeks to explore three key questions to capture the state of the art in whole building modeling:

1. How is the modeling landscape changing with the development of technology, through both established modeling methods (e.g. box models, multizone models, state-space methods or higher fidelity computational fluid dynamics models), and what can novel or developing approaches offer to meet the challenges?

2. What are the applications of the modeling methods, and what are the benefits and limitations of the various approaches?

3. How can we validate whole building models from available data sets or experimental methods, and will developing technology offer new ways to validate whole building models?

**Assessing the Validity of Computational Modelling Approaches in Predicting Particulate Matter Concentrations during Household Emission Scenarios**

114  J. McGrath*, M. Byrne

**Size-resolved indoor fluorescent bioaerosol from outdoor origin: a seven-day measurement in an office**

152  Y. Xie, O. A. Fajardo, W. Yan, B. Zhao*, J. Jiang

**Modelling of outdoor pollutant transfers in buildings**

287  E. Powaga*, B. Collignan
A CONTAM validation case study of a multi-floor office building used in the Joint Urban 2003 dispersion field trials

909 S. Batchelor, B. Lingard*, S. Parker, S. Herring

Field Observations of Dense Gas Transport in Office Trailers and Synthetic Buildings

934 M. Sohn*, W. Delp, W. Chan
Guidelines for various elevated room temperatures in summer have been issued by several governments in East Asia. Within the conditions of these guidelines, thermal neutrality cannot be provided with conventional air distributions.

To accommodate the new conditions, stratum ventilation was proposed for small to medium sized rooms, which would provide young air age in the breathing zone, reverse the vertical temperature gradient in the occupied zone and substantially lower the year-round energy consumption.

The thermal neutral temperature under stratum ventilation is above 27°C. It is found that the requirement of ADPI with at least 80% is mostly achieved. The effective draft temperature in the occupied zone is reasonably uniform. The subjective assessments of thermal sensation on the ASHRAE 7-point scale indicate that thermal sensations of subjects in stratum ventilation are also uniform because the standard deviation is under unity. The physics behind this lies with the airflow characteristics of stratum ventilation, such as air velocity and temperature profiles, turbulence intensity and the power spectrum of velocity fluctuation and their effect on thermal comfort and cooling efficiency. Room occupants’ comfort and health are affected by the airflow. Nevertheless, they themselves also play an important role in indoor air distribution. An occupant forms a local blockage but the supply airflow could flow over and around it. With the body heat from the occupant, the air jet penetrates farther. The interaction between the human body and room airflow under stratum ventilation also helps to form a uniform thermal environment.

On the other hand, under many circumstances, differentiated air parameters in different locations are required within a room to suit multiple occupants’ individual preferences. Therefore, it is desirable to simultaneously satisfy different requirements with air distribution. An optimization model to determine the supply parameters targeted at differentiated requirements was proposed. The proposed model takes the quantitative relationship between an air parameter in an arbitrary location and various boundary conditions into account, once the required parameters are specified, the supply parameters can be inversely determined instantaneously. Also, the differences between the controlled parameters should be within the capacity of the ventilation system in maintaining differentiated parameters at different locations. In this case, all the requirements can be satisfied even if the number of locations outnumbers
the supply terminals. Because of directly delivering supply air to the breathing zone (upper part of the occupied zone), the time-constant of a room under stratum ventilation is the shortest among those under whole volume air distribution systems. This unique characteristic makes stratum ventilation the best partner to this differentiation optimization technology.

**Insights on individually controlled micro-environment**
A. Melikov

**Optimization of the supply boundary conditions for accommodating individual requirements in a room of multiple occupants**
X. Li

**Indoor thermal environment characteristics of stratum ventilation**
Z. Liu
3.5 Afternoon posters
| 16:00-17:00
| UFO I-VIII
ID107 Thermal comfort performance of HVAC - C. Bin

Influence of different air distraction system on temperature barrier free and energy saving: A Case study in Japanese detached house
269  Y. Fan*

Visualization of internal airflow distribution and energy performance of a heat exchange type air flow window
697  S. Inoshima*, H. Matsumoto

Comfort evaluation of task air unit integrated with ambient air diffuser
731  T. Akimoto *, K. Yoshida, T. Yanai, T. Matsumoto, Y. Nakashima

Optimization of Radiant Terminal Laying Patterns Based on Thermal Comfort
745  X. Sui*, Y. Yan, M. Zhang, Y. Lu

Unsteady Air Supply in Displacement Ventilation: Impact on Thermal Comfort and Energy Demand
803  E. Lichtner*, N. Schultz, M. Kriegel

Evaluation of approaches to reduce plenum temperature variations in the UFAD system
905  J. Hyun Oh*, K. Hyung Yu, S. Sook Kim

Effects of Environmental Change into Different Hot Climate on Human Body
966  K. Li*

The dynamic behaviour of indoor air temperature induced by Earth-to-air Heat Exchanger (EAHE)
1101  D. Yang*, H. Wei

Experimental study of thermal comfort in a stratum-ventilated classroom with laptops
1165  Y. Cheng*, Z. Lin, A. M.L. Fong, Z. Fang
WEDNESDAY  16:00 - 17:00  UFO II

**ID92 IAQ plane boat - J. Liu**

Factors affecting endotoxins in settled dust in different indoor environments - A review
92  H. Salonen*, C. Duchaine, V. Létourneau, M. Mazaheri, S. Laitinen, S. Clifford, S. Lappalainen, K. Reijula, L. Morawska, R. Mikkola

Modelling Air Distribution in Aircraft Cabins with a Simplified Gasper Model

Investigation of reaction products of ozone and organic compounds in a simulated aircraft cabin

Study on the experimental simulation of solar load and passenger load in passenger cabin
391  Y. Cho*, D. Park, S. Bark Kwon

Personal exposure of seafarers to air pollutants and perceived indoor air quality on a passenger ferry
725  C. Österman*, S. Langer, J. Moldanova

Research on 1D-3D co-simulation for cabin air environment
752  T. Y*, X. Chen

The influence of air distribution modes in aircraft cabin on passengers’ thermal comfort
933  T. Wu, W. Cui, Q. Ouyang, Y. Zhu*, J. Kang, J. Liu

Experimental investigations on the gasper jet inside a 7-row aircraft cabin mockup
957  J. Li*, S. Dai, J. Liu

Load Calculation Method of the Air Carried Energy Radiant Air-conditioning System
1186  J. Liu*
ID151 AHU and ducts - Y.-S. Tsay

Ecodesign & Ventilation: makeover necessary?
127 Y. Lambert*, I. Pollet

Air Quality of Polystyrene, Steel, PVC and Wooden Ventilation Ducts
163 S. Kurvers*, F. van Zeist, A. Andrejevic, P. Bluyssen

Study on the Use of Anti-microbial Coating to Reduce Microbial Pollution in Ducts
232 Y.-S. Tsay*, L. Han-Chang, Y. Yu-Chun

Development of a smart inspection tool for measuring the level of contamination inside air ducts
S. Thys

Evaluation of Contribution of an Air-Conditioning and Mechanical Ventilation (ACMV) System to Level of Indoor Bioaerosols
273 J. Wen Xiong, M. Pun Wan*, V. W.-C. Chang, B. Feng Ng

Development of a modified concept and acoustic measurements of the Counterflow Heat Recovery Fan
529 C. Speer*, R. Pfluger, A. Speer

The persistence of the respiratory viruses on filters of air handling units
601 V. Bandaly*, Y. Andres, P. Le Cann

Time-Series Profile of Bioaccumulation on an HVAC Filter in a Singapore University Library
724 I. Luhung*, Y. Wu, V. W.-C. Chang, W. Nazaroff

A passive design solution for building ventilation systems: balancing energy and filter savings for maximum economic benefit during operation
807 J. Gallagher, D. Morgan, A. McNabola*

Odorant transfer in energy recovery devices for ventilation systems
1125 B. Sicre*, R. Külpmann
ID60 Clothing dermal adsorption - J. Toftum

Developing a thermal extraction method for the quantification of dimethylformamide in protective clothing

Further advances in modeling transdermal uptake of SVOCs
268  G. Morrison*, G. Bekö, C. Weschler

Dermal absorption of semivolatile organic compounds from the gas-phase: Sensitivity of exposure assessment to key parameters
468  M. Pelletier*, O. Blanchard, B. Le Bot, C. Mandin, F. Mercier, O. Ramalho, N. Bonvallot, P. Glorennec

Phthalates and alternative plasticizers and potential for contact exposure in children’s backpacks and toys
545  Y. Wu, J. Little*, M. Xie, L. Marr

Simultaneous determination of alternative flame retardants of hexabromocyclododecane in curtain

Performance test of technical cleanroom clothing systems
990  F. Romano*, B. Ljungqvist, B. Reinmuller, J. Gustén, C. Joppolo

A method for rapidly measuring air-cloth partition coefficients for SVOCs
1027  G. Morrison*, A. Eftekhari, M. Buechlein
ID131 Chemistry - R. Wells

Phthalates, Organophosphates, Polybrominated Diphenyl Ethers, Pesticides, and Their Alternatives in Indoor Air and Dust in U.S. Schools
143 H. Li, C. Bi, Y. Xu*, N. Crain, A. Novoselac, K. Kinney, R. Corsi

Exploration of the influence Nitrogen Oxides have on Terpene Ozonolysis
176 R. Wells*, J. Harrison, J. Ham, S. Jackson

Influence of suspended particles on the emission of organophosphate flame retardant from insulation boards

Ozone-initiated gaseous products on used filter surfaces during the winter haze period in Beijing 2014
256 J. Mo*, Z. Long

Ozone catalytic oxidation of acetaldehyde by manganese oxide honeycomb catalyst supported by aerosol-synthesized CVC-TiO2 particle
710 J. Jurng*

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849 M. Mendez, D. Amedro, N. Blond, D. Hauglustaine*, P. Blondeau, C. Afif, C. Fittschen, C. Schoemaecher
Senselab - a playground for the senses
65  P. Bluysen*, F. van Zeist, S. Pont, S. Kurvers

Indoor thermal conditions and air conditioner usage in high-rise residential buildings in summer, Chongqing, Southwest China
720  Y. Zhang*, M. Liu, L. Luo, D. Mmereki

Comparative Heating Performances of Ground Source and Air Source Heat Pump Systems for Residential Buildings in Shanghai
733  Z. Liu*, H. Tan

Thermal comfort and indoor air quality on end-user satisfaction level evaluation in a Nearly Zero Carbon neighbourhood
895  J. Vaillant Rebollar*, E. Himpe, A. Janssens

Assessment of thermal comfort in shopping center transitional spaces
943  M. Avantaggiato*, A. Belleri, S. Dutton, W. Pasut, R. Lollini

Indoor environmental aspects and user perception within an office landscape: an exploratory study in the Netherlands
978  J. Van Duijnhoven*, M. Aries, A. Rosemann, H. Kort

Energy consumption and energy saving means in subtropical buildings
1020  J.-i. Tsutsumi*, R. Nakamatsu, M. Matsuda

Exploring the Influence of Social Factors on Indoor Environment Quality
1059  S. Snow*, H. Gough, S. Chatterjee, A. Soska, M.C. Schraefel

Thermal comfort assessment in a Dutch hospital setting – model applicability
1063  L. Ottenheijm, M. Loomans*, H. Kort, A. Trip
WEDNESDAY 16:00 - 17:00 UFO VII

ID74 I/O measurements - J. Lo

On-site measurement of urban environmental quality for two different building configurations

The effect of urban micro-climate on Indoor-outdoor air exchange
300 H. Gough*, J. Barlow, Z. Luo, C. Halios, M.-F. King, R. Hoxey, A. Quinn

Effect of outdoor air on indoor air pollution in high-rise apartments
322 G.-N. Bae*, J. B. Kim

Influence of urban characteristics on temporal variations of indoor particles
385 M. Mazaheri*, C. Reche, I. Rivas, L. Crilley, M. Álvarez-Pedrerol, M. Viana, A. Tobias, A. Alastuey, J. Sunyer, X. Querol, L. Morawska

Can I/O ratio of PM2.5 be used to estimate air exchange rates?
910 L. Fang, J. Xiang, W. Xu, Y. Zhang*, J. Mo
ID120 General IAQ case studies and surveys - D. Rim

Comparison of Indoor Air Pesticides Contamination of Inhabitants from Five Contrasted Homes
332 M. Millet*, C. Raeppel, B. Appenzeller

Characterization of particulate matter concentrations and bioaerosol on each floor at a building in Seoul, Korea
351 H.-j. Oh*, J.-R. Sohn

Method Proposal for Energy-Saving Optimization of Office Building Façades

Indoor air characteristics of 5 typical house types in Ho Chi Minh city, Vietnam

Characterizing Exposure to Volatile Organic Compounds in Residences of Baotou, China: Concentrations, Sources and Influencing Factors
501 Z. Bu*, L. Wang, B. Li, J. Sundell, Y. Zhang

Indoor MVOCs levels and indoor dampness in 60 residential houses in East Japan
554 N. Shinohara*, K. Hasegawa, N. Kagi, J. Sakaguchi, Y. Shiraishi, T. Mitamura

Asbestos short fibers in indoor air: a first study in French building
790 T. Brown, C. Mandin*, F. Chaventre, L. Martinon, G. Boulanger

Comparison of energy efficiency rating and energy consumption of residential buildings in Korea
926 H. Gi Kim*, S. Sook Kim, J. Sang Seo
3.6 Afternoon keynotes
| 17:00-18:00
| UFO main auditorium
 Implementation of safe, healthy, energy efficient and sustainable buildings in the European Union: status and challenges

Stylianos Kephalopoulos - European Commission, Joint Research Centre, Institute for Health and Consumer Protection

Dr Stylianos Kephalopoulos is since 1993 scientific officer of the European Commission’s Joint Research Centre and is the head of the Exposure Competence Group of the Institute and Health Consumer Protection.

In the last 20 years he has been contributing significantly to the development of a number of harmonization frameworks in support of the implementation of various environment and health policies at EU level including: the development of EU harmonization frameworks concerning the labelling, monitoring and health-based evaluation of chemical emissions from construction products linked the implementation of the Construction Products Regulation; the development of the common noise assessment methods for Europe (CNOSSOS-EU) linked to the implementation of the Environmental Noise Directive (2002/49/EC); He is coordinator of the long-standing and widely recognized European Collaborative Action on “Urban Air, Indoor Environment and Human Exposure” (ECA) and is scientifically supporting DG ENER policy concerning the foundations for safe, healthy, energy-efficient and sustainable buildings in EU.

Stylianos Kephalopoulos is author of about 60 publications in peer-reviewed journals and more than 300 papers and presentations in conference proceedings and high level EU science-policy events.

Abstract: EU Member States have been developing policies and measures to generally reduce the actual energy use of their buildings with a number of challenges need to be addressed in terms of the impact of high-energy performance on the quality of the indoor climate of buildings without compromising the comfort, health and productivity of their occupants. Member States are called to properly implement and enforce the Energy Performance of Buildings Directive recast (2010/31/EU).

The objective of this lecture is to present:

1. the implementation status by the Member States of the European Union of the provisions of the Energy Performance Buildings Directive
recast (EPBD,2010/31/EU) relating to ventilation, indoor air quality and energy efficiency criteria and requirements;

2. the outcome of literature review on the impact of high-energy performance buildings (residential and non-residential) to indoor air quality before and after energy efficiency related improvements of buildings;

3. the challenges ahead at policy and technical levels to enable the effective implementation of safe, healthy, energy efficient and sustainable buildings in the European Union via a holistic approach of buildings’ “efficiency”.
KEYNOTE 4

Product emissions and the challenges of a harmonized European health evaluation (EU-LCI)
Christine Daemling

Sometimes, real life gives us the best examples of why emission tests are so important for quality control of building products before the products are installed. Germany drafted its requirements for mandatory emission tests in the early years of the new century, based on a European scientific expert’s proposal published in the ECA Report 18. Since its mandatory character and its notification to Brussels in 2005 the German regulation has fostered the lowering of emission properties in the manufacturing process. More than 4000 different products have received the approval of the construction authorities since then. The resulting higher controlled standards were attractive to industry in European competition as proof of sustainable quality. Other European countries followed in setting national regulations to improve indoor air quality.

The need for a harmonized evaluation of building products has been recognized. The national requirements are still divergent on how the emission qualities are evaluated. The comparison tests between different labeling schemes (voluntary and mandatory labeling systems) have shown the need for a long list of evaluated substances and their respective LCI (Lowest Concentration of Interest) values – for the European market - a harmonized, science-based toxicological evaluation.

Can these LCIs be helpful for evaluation of other indoor products like furniture or commodity products? Challenges remain including the definition of “EU-LCI” as these were intended for application to chamber measurements of single products under defined conditions. The derivations of “indoor air guideline values” include similar scientific paths of toxicological evaluations but may include other considerations such as odour, and building types and unlike LCIs are not limited to an assessment of product performance under a particular exposure scenario. In the gap between these two perspectives are the whole complexity of the indoor environment with its multiple sources, ventilation, temperature, humidity and temporal variation and occupancy patterns.
DAY

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4.1 Morning keynotes
| 08:30-09:30
| UFO main auditorium
KEYNOTE 1

Indoor microbial communities as seen through the lenses of molecular biology, particle transport physics, and chemistry
Tom Bruns - Department of Plant & Microbial Biology, UC Berkeley

The study of indoor environments is a mature science that has traditionally incorporated building design to lessen or avoid health problems associated with microbes and materials in our buildings. The influx of methods from molecular microbial ecology has introduced new tools for this field that have provided a more complete census of microbes and a greater understanding and quantification of their sources. “Healthy” buildings, rather than problem buildings, have been the primary focus of this new work, and what has been found is that the indoor microbes are overwhelming immigrants. Indoor fungal communities for example are largely a filtration of the outdoor community, and the greatest predictor of their composition is geography. The bacterial communities similarly have a large outdoor source, but are also shed from humans and pets and can be attributed to individuals with surprisingly specificity. Human presence and activity is emerging as the greatest source of biological particles in the indoor air due primarily due to resuspension from floors and clothing and to a lesser extent from shedding of resident microbes.

One major drawback to these studies is that it remains unclear what microbes are actively growing in the indoor environment, and this is obviously an important component in the context of problem buildings. This issue arises because immigrant populations are so much larger that they likely mask any true residents, but it also reveals a limitation of DNA detection methods that usually cannot distinguish between active, live but quiescent, or dead microbes. Live dead assays and RNA-base approaches have potential to help resolve this issue, but these methods have technical limitations that make them far from ideal. Volatile chemicals emitted from microbes also have potential as specific markers of activity, and the high sensitivity and resolution of modern mass spectrometry is reopening this view of the indoor environment.
KEYNOTE 2

A “Skinful” of Secrets: Dermal Exposure and Effects
Gabriel Bekö - Department of Civil Engineering, DTU Civil Engineering

Biomonitoring has shown that humans have body burdens of manufactured chemicals, including semivolatile organic compounds (SVOCs). Many of these SVOCs may have adverse health effects or are categorized as potential endocrine-disrupting compounds. Exposure to these indoor pollutants can occur through dietary and nondietary ingestion, inhalation, and dermal absorption. In assessing human exposure to organic pollutants indoors, inhalation and ingestion of dust are routinely included as exposure pathways. The dermal pathway, which is rarely considered, is limited to contact transfer of a pollutant in contaminated surfaces or in dust. Physical and chemical properties control the process by which a compound travels from its original indoor source across the skin and into the body. Transdermal uptake directly from air has been documented only for volatile organic compounds and is frequently assumed to be negligible for SVOCs. However, recent efforts to model dermal uptake directly from air indicate that it may be comparable to or larger than inhalation uptake for many SVOCs found indoors. Experimental data supporting these findings have only started to emerge. Dermal uptake of SVOCs may not only impact dermal health but their health consequences may vary with exposure pathway. This talk will summarize what we know about how SVOCs migrate through skin into the bodies of building occupants and the effect of this exposure.
4.2 Morning posters
| 09:30-10:30 |
| UFO I-VIII |
THURSDAY  09:30 - 10:30  UFO I

ID105 Thermal comfort performance of HVAC - G. Beko

Evaluation of thermal comfort, indoor air quality and energy saving of a Local Exhaust Ventilation system in an Office room (LEVO)
304   A. Ahmed*, S. Gao, A. Kareem

Development of Desiccant Air Conditioning System using Wakkanai Siliceous Shale
306   Y. Nabeshima*, J. Togawa, K. Nagano

Equivalent temperature based comfort zone study under task/ambient conditioning system
318   Y. Ren*, L. Duanmu, Q. Jin

Heat Stress and Direct Load Control Air Conditioning in Homes
357   P. Paevere*, Z. Ren, J. Anticev, O. Motlagh

Development of a Task Desk Equipped with Radiant Cooling and Heating Systems

381   S. Sakai*, T. Akimoto, Y. Miyasaka

Physiological and psychological effects on workplace productivity of HVAC control based on the metabolic rate of office occupants
386   R. Tsuchiya*, T. Ikaga, M. Miura, K. Harayama, K. Mizutani, S. Ogawa

Effect of using a local heating device in a cold toilet on thermal comfort in winter
395   J. Ishii*, S. Watanabe

Heat Storage Efficiency of a Floor Heating System under Demand Response
ID121 Pollutant containment and infiltration - I. Pollet

Improvements in natural air supply concerning thermal winter comfort, IAQ and energy consumption
129 I. Pollet*, F. Losfeld, A. Vens, A. Candaele, J. Laverge

A novel air diffuser solution for control of indoor air particle concentration

Characterization of sewer systems as a major intrusion pathway for VOC’s to indoor air
581 B. Hvidberg*

Challenges in estimating natural ventilation
824 J. Lo*

Residential Natural Gas Emissions from Pipe Leaks and Heating Appliances
987 Z. Merrin*, P. Francisco, S. Gloss

Experimental study of heating energy use and indoor environment during operation of active soil depressurization radon mitigation system
1129 L. Zhou*, J. Whyte, M. Armstrong

In-Situ Analysis of Radon Trends in a Smart Home and Development of Energy Efficiency Improvements via Smart Cycling
1158 M. Panzarino, P. Jansson*, H. He

Wind Tunnel Tests of Pollutant Inter-flat Dispersion Characteristics in Slab-shape Multistory Residential Buildings
1164 D. Mu*, N. Gao
ID122 Demand controlled ventilation - R. Van Gaever

The study of the impact of demand controlled ventilation in energy consumption of offices in Portuguese commercial buildings

J. Monteiro*, M. Almeida, O. Castro

The circadian rhythm of total volatile organic compounds, carbon dioxide, and formaldehyde concentrations and the physical parameters in rooms with and without air-related irritation symptoms

E. Castagnoli*, R. Mikkola, J. Kurnitski, H. Salonen

A comparison of the effect of carbon dioxide and relative humidity sensitive ventilation systems on indoor air quality, hygrothermal and energy performance in an office room made of hemp concrete


Effect of alternate/occupancy controlled ventilation in schools on the exposure quantification

C. Schoemaeker, V. Fèvre-Nollet, M. Verriele, S. Dusanter, S. Le Calve, C. Trocquet, B. Hanoune*, N. Locoge
ID62 Pathologies - J. Sundell

The association of home environment and life style with children asthma in Beijing, China: A Cross-Sectional Study
62 S. Huang*, J. Sundell, Y. Zhang, Y. Zhang

National survey on home dampness and children’s allergic symptoms during consecutive survey periods in Japan
400 K. Hasegawa*, N. Kagi, J. Sakaguchi, N. Shinhara, Y. Shiraishi, T. Mitamura

Fungal Sinusitis as a Possible Consequence of Poor Indoor Air Quality
525 E. Pieckova*, M. Majorošová, S. Wimmerová, J. Štrelinger

Allergenic potency of birch pollen
553 D. Wahlborg*, M. Bjorling, L. Andersson

Associations between residential characteristics and childhood illnesses regarding eczema in Shanghai, China: a cross-sectional study
563 J. Cai, W. Liu, C. Huang*, Z. Zou

Home dampness and childhood asthma and allergic symptoms-the influence of ventilation in more than 40,000 Chinese preschool children in 8 cities
700 Z. Zhao*, Z. Lin, T. Wang, X. Zhang, H. Qian, Q. Deng, B. Li, C. Huang, X. Yang, Y. Zhang, D. Norback, J. Sundell

Evaluation of perceived indoor environmental quality of five-star hotels in China: a text-based approach
787 M. Qi, E. Zhu, X. Li*

Hoarseness is associated with indoor air problems among teachers
797 T. Putus*, H. Vertanen-Greis, J. Uitti

Associations of residential environment and lifestyle habits with eczema among preschool children in Shandong, China
1127 J. Chang*, C. Huang
ID97 Emerging analytical tools - G. Morrison

A sensitive method using SPME pre-concentration for the quantification of aromatic amines in indoor air
333 M. Millet*, V. Lucaire, J.-J. Schwartz

Evaluation of diffusion parameters of new passive samplers for on-site measuring formaldehyde in indoor air: Experimental and numerical studies
437 P. Mocho*, J. Vignau Laulhere, H. Plaisance, V. Desauziers, K. Raulin

A sampling method for very volatile organic compounds (VVOCs) using carbonaceous multi-bed sorbents
487 J. Freitag*, A. Schieweck, J. Gunschera, T. Salthammer

Evaluation of a tube-type passive sampler in the chamber by the methods described in ISO 16107
759 ZW. Wang*, Q. Wang, Y. Miyake, T. Amagai, Y. Fukushima, Y. Suzuki, T. Enomoto

Non-linear optics for real-time field studies on IAQ
788 O. Le Mauguen*

Traceability for formaldehyde measurements
843 S. Persijn*, A. Baldan, D. Heikens

Single stage centrifugal air sampler: A theoretical, numerical and experimental approach for cut off size (d50) evaluation
1001 L. Sabatini*, F. Romano, L. Marocco, J. Gustén, C. Joppolo

Application of a novel portable gaseous formaldehyde microanalyzer based on microfluidic device for real-time monitoring during the field MERMAID campaign
1098 C. Trocquet, P. Bernhardt, M. Berger, I. Malandain, C. Liaud, S. Englaro, S. Le Calve*
ID68 Low energy buildings - E. Van Kenhove

Energy Consuming Behavior of the Occupants in a Zero-Energy House
330 A. Shibutani*, S.-I. Tanabe, N. Nagasawa, T. Matsunaga, K. Utsumi, M. Ebe

Research on Demonstrative Building of Net Zero Energy House
444 M. Takata*, T. Akimoto, Y. Kawaraguchi, S. Tazawa, Y. Miyazawa

Comparative analysis of volatile organic compound concentrations at different construction stages of energy-efficient timber frame houses: temporal trends and source identification
582 V. Desauziers, H. Plaisance*, P. Mocho, J. Vignau Laulhere, N. Sauvat, K. Raulin

Long-term investigation measurement and questionnaire on terminal Indoor Environment Quality in Shenzhen Bao’an International Airport
676 C. Zhang*, B. Lin

First analysis of the national database on indoor air quality and comfort in energy-efficient buildings
927 M. Derbez*, G. Wyart, O. Ramalho, J. Ribéron, S. Kirchner, C. Mandin

Formaldehyde Concentrations in a Net-Zero Energy House: Real-time Monitoring and Simulation
992 D. Poppendieck*, S. Khurshid, S. Dols, L. Ng, B. Polidoro, S. Emmerich

IEA EBC Annex 68 - Indoor Air Quality Design and Control in Low Energy Residential Buildings - Setting the Metrics
1009 M. Abadie*, P. L. Wargocki, C. Rode

Net-zero Energy Housing Research on the Pine Ridge Indian Reservation
1019 K. Cameron*, L. Bailey, R. Pyatt, J. Benning
THURSDAY 09:30 - 10:30  UFO VII

**ID113 Emissions from building products - T. Haerinck**

*Formaldehyde Emission Rates From Lumber Liquidators Laminate Flooring Manufactured in China*
88  B. Offermann*

*Weathering of natural fibers reinforced composites: study of the impact on Volatile Organic Compounds' emissions in indoor air*
543  C. Badji*, J. Beigbeder, H. Garay, A. Bergeret, J.-C. Bénezet, V. Desauziers

*Measurement of Chemical Emissions from Spray Polyurethane Foam (SPF) Insulation Using an Automated Micro-Scale Chamber System*
565  Y. Nie*, K. Thaxton, E. Kleine-Benne

*Analysis of the indoor air VOC concentration and emission rates of building materials in six new residential timber frame buildings in Belgium*
1058  T. Haerinck*, L. De Boever

*Occurrence and Source Identification of TXIB in Indoor Air of the Rhine/Main area, Germany*
1149  L. Zhou*, M. Hilscher, W. Püttmann
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<td>C. An, N. Yamamoto*</td>
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<td><strong>Evaluation of the exposure to the mycotoxins aerosolized after</strong></td>
<td>B. Aleksic*, M. Draghi, S. Ritoux, S. Bailly, M. Lacroix, I. Oswald, J.-D. Bailly, E. Robine</td>
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<td>development of toxigenic moulds on wallpaper**</td>
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<td><strong>Fungal aerosols and diversity in mouldy indoor air</strong></td>
<td>A. Komlavi Afanou*, I. Engh, A. Straumfors, L. Madsø, J. Mattsson, W. Eduard</td>
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<td><strong>259</strong></td>
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<td><strong>Airborne bacteria and fungi in different indoor environments: levels and dose rates</strong></td>
<td>I. Paciência*, J. Madureira, J. Cavaleiro Rufo, L. Aguiar, J. Paulo Teixeira, M. Pinto, A. Moreira, E. de Oliveira Fernandes</td>
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<td><strong>Measured Colony Forming Units in Operating Rooms with Temperature Controlled Airflow</strong></td>
<td>H. Bashir*, S. Holmberg, P. Ekolind</td>
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<td><strong>Evaluation of mould growth in a sport facility using different predicting models</strong></td>
<td>E. Barreira*, R. Almeida, N. Ramos</td>
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<td><strong>Size distributions and composition of inhalable microbial aerosols in indoor and outdoor air in Singapore</strong></td>
<td>Y. Wu*, I. Luhung, W. Nazaroffv. W.-C. Chang, A. Chen</td>
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<td><strong>Microbial Analyses of Airborne Dust Collected from University Dorm Rooms</strong></td>
<td>S. Miller*, J. Luongo, N. Fierer</td>
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4.3 Morning presentations
| 11:00-12:30
| PLA C-K
Long-term climate objectives involve policies aiming to reduce greenhouse gas emissions related to buildings. Green/sustainable building is a commonly used definition referring to the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. However, there seems to be significant variation in the degree to which green/sustainable building guidelines consider indoor environmental quality and therefore, the impact on occupant health is unknown. Recent studies have emphasized the need to ensure good indoor environmental quality as a part of healthy green/sustainable building practices.

**Indoor air quality requirements in green building certifications**  
C. Mandin

**Green building studies in the US**  
T. Reponen

**European studies on how improving energy efficiency of buildings affect indoor environmental quality; implications on EPBD and labelling homes**  
U. Haverinen-Shaughnessy

**WHO Healthy Housing Guidelines**  
M. Braubach

**Discussion**
Papers in the area of indoor air that were done with any numerical simulation approaches will be presented and discussed in this session.

**Modeling Particle Deposition on the Surfaces around a Diffuser in an Indoor Space**
89 C. Chen*, C. Lin, D. Wei, Q. Chen

**CFD simulations of mixing ventilation at low Reynolds numbers: effect of spatial discretization scheme**
108 T. Van Hooff*, B. Blocken

**The Dynamic Simulation of Contaminant Air Invasion Produced by Door Movement**
116 L. Chang*, X. Zhang, Y. Cai

**Numerical Investigation of Door Motion between Clean Rooms**
806 T. Askan*, M. Kriegel
Demand controlled ventilation (DCV) refers to a ventilation system with airflow rates that are controlled based on a measurement of an indoor air quality parameter.

Different factors such as legislation and awareness to climate change enforce buildings to become more energy efficient, in such a way that nearly Zero Energy Buildings are or will become the standard in coming years. To achieve nearly net zero energy use, merely increasing insulation thickness and airtightness is insufficient and buildings will need to be optimized in an integrated way. In this, the ventilation system is a crucial part and energy demand for ventilation can be reduced by lowering the ventilation rate to the minimum necessary.

It is a proven fact that Demand Controlled Ventilation significantly reduces the energy use of ventilation compared to constant ventilation systems. However, it is often unclear what the minimum necessary ventilation rate represents. After all, the risk of poor indoor air quality (IAQ) increases. In this session we want to explore the effect of Demand Controlled Ventilation on indoor air quality, ventilation effectiveness and energy efficiency. We are interested in sharing knowledge on the impact of the indoor air quality parameter used for control (CO₂, temperature, VOC,...), of the position of sensors or the position and type of supply and extraction grills, on the ventilation efficiency at reduced ventilation rates, on the impact on energy use for electricity, heating and cooling of the building. Moreover, we welcome contributions that explain how the ventilation rate can be controlled in the ventilation system, which novel types of ventilator control strategies can be used or how ventilation components (e.g. reacting on pressure difference) operate in reduced ventilation rate situations. Furthermore, this knowledge can lead to proposals for adaptations to currently used design strategies for ventilation systems and their control.

Ventilation Impact of Outdoor CO₂ Concentration Increase

M. K. Kim*, X. Jiaotong
Residential demand controlled extract ventilation combined with heat recovery via a heat pump
128 I. Pollet*, C. Coulier, A. Vens, F. Grillet

Accuracy of People-counting System Based on Motion Detection for Demand Controlled Ventilation
135 K. Lee*, B. Lee

Impact of demand controlled ventilation on indoor air quality, ventilation effectiveness and energy efficiency in a school building
281 B. Merema*, H. Breesch, M. Sourbron
THURSDAY  11:00 - 12:30  PLA E

ID15 Health impact of air pollution on sensitive groups (infants/children, elderly and asthma patients) - D. Kelly

Recent research has shown that the fraction of particulate matter smaller than 100nm, known as ultrafine particles, may be the most critical in terms of health impact. This is particularly true for certain vulnerable groups such as pregnant women, infants/children, cardiovascular patients, elderly, asthma patients and COPD patients.

Opening talk - Health impact of ultrafine particles on sensitive groups - an emerging research topic
D. Kelly, F. Suijver

The State of the Science Regarding the Potential Health Risks of Indoor Exposure to Particulate Matter
206  D. Butler*

Early home environment and the change of home environment in relation to the new onset and remission of asthmatic and allergic symptoms in 4246 preschool children in Urumqi, China
394  Z. Lin*, D. Norback, Z. Zhao, H. Kan, X. Zhang, T. Wang

More SBS Symptoms of Parents, More Asthma and Allergic Rhinitis of Children
465  L. Wang*, Y. Zhang, J. Sundell

The Canadian Healthy Infant Longitudinal Development (CHILD) Study: Indoor markers of moisture in a prospective birth cohort.
THURSDAY 11:00 - 12:30 PLA G

ID45 Emerging analytical tools for the monitoring of indoor air composition - S. Le Calvé

It is necessary to be able to monitor in real-time the air quality in indoor environments, so as for instance to control the ventilation system, or to trigger corrective actions when the pollution levels are above acceptable values. This cannot be conveniently achieved with the conventional equipment, usually bulky, noisy, and expensive, nor by passive samplers which do not provide real-time measurements. Miniature sensors are promising devices, increasingly used by scientific research groups, by the professional community for controlling the ventilation, or directly by citizens. Still, many questions are yet unanswered, such as the selectivity of the sensors, or the proper way to interpret the data from the sensors...

Improved Sampling Method for Organic Nitrates
174 R. Wells*, J. Ham, S. Jackson, J. Harrison

Applicability of carbonaceous sorbents for the determination of very volatile organic compounds (VVOCs) in indoor air
485 J. Freitag*, A. Schieweck, J. Gunschera, T. Salthammer

Using In Vitro oral digestion model and SPME-GC/MSMS to assess bioaccessibility of endocrine disrupting compounds in indoor dust
503 A. Sonnette*, L. Alleman, P. Coddeville, M. Millet

New developments in diffusive sampling for IAQ monitoring
519 E. Goelen*, F. Maes, W. Swaans, M. Spruyt, F. Geyskens, G. Otten

Portable novel micro-device for BTEX real-time monitoring: assessment during a field campaign in a low energy building
1100 R. Nasreddine, V. Person, C. Serra, C. Schoemaeker, S. Le Calve*

Analysis of very volatile organic compounds with thermal desorption GC-MS
889 A. Pech*, O. Wilke, W. Horn, O. Jann
This workshop will focus on IAQ, ventilation and summer thermal comfort requirements development within the review process of EPBD directive and preparation of EPBD standards. Current EPBD includes the statement that indoor climate cannot be compromised when improving energy performance. However, in practice the EPBD was implemented in most MS without paying attention to indoor environmental quality which has led to serious IAQ and mould problems especially in renovations. It is well known that insulation and air tightness improvements stop natural air change and lead to poor IAQ as well as to significant mould and health problems if controlled ventilation is not arranged when implementing energy efficiency measures. There is also evidence that if properly applied heat recovery ventilation serves also as energy efficiency measure, improving IEQ and efficiency at the same time. To achieve a win-win situation, this workshop will discuss how the EPBD shall handle ventilation and IAQ as a complementary area supporting energy efficiency targets and ensuring indoor environmental quality.

Expected outcome: workshop statement how to fit IAQ and ventilation requirements into regulatory framework under review and how to strengthen the role of European standards.

nZEB regulation – does it cover IAQ and ventilation requirements?
J. Kurnitski

JRC input on inclusion of indoor climate issues to EPBD and EED review – DG ENER/JRC Task 13.3 ‘Relation between high-energy performance and indoor air quality’
S. Kephalopoulos

IAQ and ventilation in EPBD standardization package – revision of EN 15251 (prEN16798-1) and developments in IAQ and ventilation criteria
B. Olesen

Moderated discussion with main discussion points on:
1 Possibilities to address IAQ in current regulatory framework and its review process.
2 Should EPBD address minimum ventilation requirements or something else to ensure that indoor climate will not compromised.
3 Role of standards - how widely EN 15251 has been used?
THURSDAY 11:00 - 12:30  PLA J

ID2013 Building materials and references emissions - M. Stranger

Emissions of very volatile organic compounds (V VOC) from particle boards
965 O. Wilke*

Health-based evaluation of chemical emissions from construction products to indoor air: Development and application of the EU-LCI harmonisation framework
96 D. Crump*, P. Harrison, K. De Browere, A. M. Scutaru, C. Daeumling, P. Wolkoff

Comparison of VOC emissions from individual and combined building products
299 F. Maupetit*, J. Nicolle, M. Nicolas, P. Blondeau

VOC emissions of materials used in the construction of energy-efficient timber frame houses: chemical composition and emission kinetics
599 H. Plaisance*, J. Vignau Laulhere, P. Mocho, N. Sauvat, V. Desauziers

834 M. Khare*, S. Gulia, S. Chinthala, C. Rana, K. Mower, C. da Silva, A. Dengel

Research on radon emission on the building materials in Korea
842 D. Lee, S. Lim, H. Ju Park*, C. Lee
ID2010 What have we learned from studies of indoor microbiomes in different environments? (Sloan) - J. Siegel

Is there something unique about what new has been learned by studying the indoor microbiome that indoor environment researchers hadn't learned by studying other aspects of the indoor environment?

Lessons Learned: Microbiome Assessments in Non-Residential Environments
1111 K. Kinney*, A. Hoisington, J. Maestre, J. Siegel, M. King

Building Plumbing Design Shapes Water Microbiome: An important Source of Indoor Air Microbes
635 A. Pruden*, M. Edwards, W. Rhoads, P. Ji, D. Dai, A. Pearce

New methods meet an age-old concern: Microbes in the classroom
985 S. Bhangar*, W. W. Nazaroff

Microbial growth in hidden locations as the source of indoor air contamination
1192 M. Pitkaranta*, J. Repo, K. Laine

What is known about current microbial science, the built environment, and health?
J. Bennett*
4.4 Afternoon presentations
| 14:00-15:30  
| PLA C-K
ID18 Indoor environmental quality and health in green/sustainable buildings, part 2 - U. Haverinen-Shaughnessy

Long-term climate objectives involve policies aiming to reduce greenhouse gas emissions related to buildings. Green/sustainable building is a commonly used definition referring to the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building’s life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. However, there seems to be significant variation in the degree to which green/sustainable building guidelines consider indoor environmental quality and therefore, the impact on occupant health is unknown. Recent studies have emphasized the need to ensure good indoor environmental quality as a part of healthy green/sustainable building practices.

Impact of the new Chilean air-tightness regulation on indoor air pollution in dwellings with inefficient heating sources
199 C. Shrubsole*, R. Narváez Sotomayor, H. Altamirano-Medina

Comfort of cooling by personal air movement
580 J. Verhaart*, L. Quaas, W. Zeiler, R. Li

The effects of improved energy efficiency on indoor environmental quality in multi-family buildings
737 L. Du*, T. Prasauskas, V. Leivo, M. Turunen, M. Kiviste, D. Martuzevicius, U. Haverinen-Shaughnessy

Ventilation performance and indoor air pollutants diagnosis in 20 French low energy homes

What do people need from energy and indoor environments?
1106 G. Raw*

Impact of Green Mark certification scheme on the quality of indoor environment in office buildings in Singapore
1130 P. L. Wargocki*, N. da Silva, K. Wai Tham, C. Lim, J. Young Lee
Traditionally, monitoring of indoor air quality and taking measures is conducted by professionals. Instead of this approach, consider one where those people who have a stake on the issue are given the instruments to monitor the air. In this citizen science approach, citizens contribute to the scientific process by collecting data and sharing their observations, while also contributing to the benefits accruing to the wider community. In society, citizens take more responsibility of their environment by participatory processes; this increases citizen engagement in societal activities that can benefit all. The domain of the indoor environment is still underdeveloped with regard to citizen participation. The indoor environment is defined in the context of this workshop as locations where people spend their time indoors such as homes, schools, offices, shops, restaurants, etc. The way citizen science is used, and the users, will differ by type of environment. The discussion in this workshop focuses more on citizen science in the specific indoor context of schools, by using examples from the EU-funded Citi-Sense project and other solicited examples.

All you need to know about indoor air: a guide and a questionnaire for creating awareness
63    P. Bluysen, M.A. Ortiz*, A. Andrejevic, F. van Zeist, C. Roda, S. Kurvers

Evaluation of Portable HEPA Air Purifiers against Traffic Related Ultrafine Particles with input from Community
248    T. Reponen*, R. Peck, M. Yermakov, J. Kim, M. Rao, S. Grinshpun

Will indoor environmental training modify pupils’ perception of how air quality affects their health?

High school students as potential actors in monitoring and improving indoor environmental quality: scientific quality of work performed by students involved in CITI-SENSE pilot studies

Is a project aiming at engagement of citizens a biased activity? Is that a problem?
743    H. Keune, P. van den Hazel*, J. Robinson, S. Holøs, B. Kastad Hoiskar
Increased knowledge and scientific thinking following participation of school students in air-quality research

Y. Golumbic*, A. Baram-Tsabari, B. Fishbain
The topic of this session is “next generation” ventilation strategies and technologies. Some examples of recent “next generation” ventilation research includes the following. One, there has been a wave of recent research on new smart ventilation technology ideas that move beyond CO2-based demand controlled ventilation to incorporate real-time information on time of use energy prices, outdoor air pollutant concentrations, and indoor air pollutant concentrations. This work not only involves advancing sensor technologies and data collection platforms, but also integrates other disciplines via the need for advanced control and optimization algorithms, real-time co-simulation, and real-time model-predictive-control systems. Two, research on natural ventilation and hybrid mechanical/natural ventilation has only recently moved into a more quantitative state, and we are still understanding how to accurately measure hybrid or natural ventilation flows and to account for the energy and IAQ impacts of their operation. Third, there is ongoing work in personalized and localized ventilation strategies that target pollutant reductions in the places that matter most (i.e., directly in people’s breathing zones). This session will highlight novel concepts and applications in this area. Finally, advances in these advanced ventilation strategies are continuing to advance at different paces across the world, with stark regional differences in system use, system design, applications, and sensor requirements. Different regions can learn from each other, so in this session we will purposefully target an internationally diverse mix of work. Ultimately this session will highlight novel concepts and advances in the “next generation” of ventilation, which will then inform an agenda for the next decade of ventilation research and applications.

An integrated utility maximization approach to next-generation commercial building ventilation
321 A. Rackes*, T. B. David, M. Waring

Technological Dependant Ventilation Strategies in Energy Efficient Social Housing- A UK Case Study
323 G. McGill*, T. Sharpe

Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings
346 P. MacNaughton*, J. Pegues, U. Satish, S. Santanam, J. D. Spengler, J. Allen
Performance evaluation of ducted and ductless personal ventilation systems
898 M. Schuss*, A. Mahdavi, M. Taheri, U. Pont

Pollutant exposure control strategies in commercial buildings
986 M. Zaatari*

Smart management of IAQ based on real-time sensing of pollutants
1056 D. Martuzevicius*, D. Ciuzas, A. Mikuckas, T. Prasauskas, E. Krugly, A. Jurelionis
ID24 What is the role of “health” in indoor air science? - Y. Sun

Indoor air science is driven by health, e.g. lung cancer - radon; SBS =, formaldehyde, VOCs; modern diseases - SVOCs and other new chemicals.

In this workshop, we would like to get input and discussion from the audience on what is the future of health in indoor air science.

Indoor air humidity and associated health effects
134  P. Wolkoff*

Asthma, Airway Infections and Rhinitis among Adults in Relation to measured Home Environment in Single-family Buildings in Sweden

A follow-up study on ventilation in dormitory and its association with respiratory infections
583  P. Wang*, Y. Sun, Q. Zhang, J. Hou, J. Sundell

Phthalate Concentrations in Dust Collected in Children’s Bedrooms and its Health Effects
746  Q. Zhang*, Y. Sun, P.Wang, J. Hou, X. Kong, J. Sundell

Discussion about the importance of health in indoor air science
ID1178 Changing the game in the management of Indoor Air Quality - Real time monitoring for improved health, comfort and energy efficiency - J. Petry

The session is composed of six short presentations from highly recognized scientists in Indoor Air Quality and leading industrial players in the field of sensor systems as well as integrated building technologies. The session will start with a brief introduction concerning indoor pollution and its impact on health and comfort. Then, two current EU funded projects – IAQSense and SENSIndoor – will present recent developments in low cost sensors systems for selective VOC monitoring in indoor environments, their performance and interfacing with building control systems as well as their potential for monitoring and control. The presentation will provide an outlook on integrated solutions for building management but also sensor-based control for small integrated ventilation systems as well as future requirements.

**Indoor air quality: Sense or not?**
S. Kircher

**IAQSense – Real-time Monitoring of Indoor Air? With the innovative Spectrometer on Chip**
C. Iroulart

**Integrated microsensor system with selective pre-concentration for ubiquitous IAQ monitoring**
A. Schütze

**Sensor systems integration and available interfacing**
T. Conrad

**How to use and optimize the data coming from a new IAQ sensor**
R. C. Socorro Hernández

**Integrated ventilation solutions for future demands – an outlook**
M. Sándor
ID1182 Results from a large multidisciplinary study center; CISBO - T. Sigsgaard

This session covers studies on particulates and health performed over the last 5 years. The studies cover exposure indoor, as well as the effects of indoor and outdoor particle sources. The studies comprise exposure monitoring and source apportionment, intervention studies as well as experimental studies on middle aged citizens. After the presentations, there will be a discussion of the future challenges for indoor research in the field of particulates and health indoor, headed by CISBO advisory board members.

Diurnal and seasonal variation in air exchange rates and interzonal flows measured by active tracer gas in five Danish homes

1193  G. H. Clausen*, G. Bekö

Anybody home? - Indoor microbial exposure in Danish residences


Ultrafine particle exposure in Danish residencies

1194  G. Bekö*

Indoor-outdoor particle effects on health in middle-aged and elderly


Intervention reducing particle exposure in Homes of 50+ year olds

888  L. Gunnarsen*, M. Spilak, D. G. Karottki, M. Frederiksen, B. Kolarik

Increasing ventilation as an intervention in homes of asthmatic children


XDOZ; Controlled human exposure to indoor air dust and ozone

1118  G. Elholm*, J. Bønløkke, V. Schlünssen, S. Loft, P. Wolkoff, T. Sigsgaard
Cooking emissions have long been seen as an odor problem. However due to the airtight construction of dwellings and the lack of effective ventilation cooking emissions might become a major source of fine dust exposure. Several papers report in different markers for cooking emissions: NOx, particulate matter (PM2.5), particle number count. Which marker is most representative with regard to health? What is the effect of different cooking methods like gas and induction? And what is the effect of different food types and cooking oils? High capacity exhaust hoods may effective but worse the energy efficiency due to the large amounts of air which needs to be preheated during winter time. The European committee has recently brought out legislation with minimum requirements and a labeling system for energy efficiency of exhaust hoods. This is a first step ahead, however the current legislation only addresses the fan energy and does not address the capture efficiency and thus the effectiveness of the hood.

A Field Survey on the Environmental Quality of Kitchens during Heating Period in northeastern China
221 B. Chen*, M. Zhou, Y. Xu, C. Zeng

Energy efficient measures to reduce PM2.5 emissions due to cooking
781 P. Jacobs*, E. Cornelissen, W. Borsboom

Associations between Household Usage of Cooking Fuels and Respiratory Symptoms in Middle-School Teenagers
1025 L. Li*, J. D. Spengler, J. Sundell, S.-J. Cao, M. Alvarez-Reeves, G. Adamkiewicz

Effect of cooking medium on emissions during normal and festival cooking: A case study of urban domestic kitchen, India
1109 S. Khandelwal*, N. Kaul, A. Gupta, G. Das

Importance of ventilation provisions in efficient dispersion of particulate and gaseous pollutants: A case study of different cooking microenvironments, India
1110 N. Kaul*, S. Khandelwal, A. Gupta, G. Singh
ID2011 What have we learned from MoBE research that can actually be applied to buildings? - H. Levin

Do we know whether microbial diversity in buildings matters? If “yes” what can we do about it?

Microbial diversity, buildings, and human health
612 J. Peccia*

Application of the Environmental Relative Moldiness Index in Finland

Gut microbiome, biodiversity, building connection
D. Thaler*

Prebiotic Buildings: A note of caution
968 J. Siegel*

Floods and whatever
M. Hernandez*
4.5 Afternoon posters
| 16:00-17:00
| UFO I-VIII
THURSDAY  16:00 - 17:00  UFO I

**ID56 Ventilation measurement technologies - W. Fisk**

Applicability of personal monitors for assessing the exposure to indoor nanoparticles

C. Asbach*, H. Kaminski, C. Monz, D. Dahmann, V. Neumann, M. Fierz, S. Clavaguera, S. Plitzko, A. Meyer-Plath, B. Simonow, I. Iavicoli, L. Fontana, A. Maria Todea

Wind effects on tracer gas dispersion between horizontal adjacent units in a building

Y. Wu*

Experimental assessment of the ventilation in a residential building: Tracer gas and fan pressurization measurements

R. Almeida*, E. Barreira, N. Ramos

Using a combined instrumentation system to measure the penetration of ambient ozone and fine and ultrafine particulate matter into residential buildings

H. Zhao*, B. Stephens

Innovative use of fluorescein microparticles for the air path study through airtightness defects in timber frame wall assemblies

N. Hurel*, M. Pailha, M. Woloszyń

On Measuring Air Infiltration Rates Using Tracer Gases in Buildings with Presence Controlled Mechanical Ventilation Systems

M. Bjorling*, J. Akander, J. S. Englund

Open-source tool for the automated analysis of air exchange rates

J. G. C. Laurent*, R. Sanchez-Pina, P. MacNaughton, J. Spengler, J. Vallerino

Estimation of air exchange rate from CO2 level

Y. Ssu-Hui, N.-Y. Hsu, J. J. Zhang, H.-J. Su*
### THURSDAY 16:00 - 17:00 UFO II

#### ID73 Household activities/occupancy - B. Olesen

**A One-year Round Study: Spatial Variations of Indoor VOC Levels and Influences of Building/Environmental Characteristics and Occupants’ Habits (Basic Indoor Air Pollution Index)**

336 S. Mentese*, D. Tasdibi

**Coupled indoor/outdoor airflow simulation comparing Fluent with a real-time GPU-based Lattice Boltzmann method**

355 M.-F. King*, A. Khan, C. Noakes, H. Gough, J. Barlow, N. Delbosc

**Household formaldehyde exposure in relation to lifestyles behaviors and dwelling characteristics in 454 residences of Shanghai, China**


**Investigating correlation between occupant activities and generation of indoor air pollutants in Ho Chi Minh City, the fastest-growing city in Vietnam**

383 D. N. T. Kieu*, T. T. T. Tran, T. Ng. Tran, L. H. Ba, O. Michel, C. Bouland, J.-M. Hauglustaine

**Contribution to Indoor Aerosol Concentration from Common Household Powders**

450 M. Byrne*, R. Thomas

**Predictive Control of Indoor Environment Using Estimated Occupant Number by Video and CO2 Concentration**

528 Z. Chen, F. Wang*, Q. Zhao, Z. Cheng, J. Zou, Y. Zhang, J. Mai, Y. Li, H. Reeve

**Prediction of user-driven window operation in buildings**

750 A. Mahdavi*, M. Del Bolgia, F. Tahmasebi, M. Schuss

**Effect of outdoor temperature on occupants’ window opening in residential buildings**

782 B. Jeong, J. Seok Park*

**Toward a systematic assessment of window operation models in buildings**

816 A. Mahdavi, F. Tahmasebi*, M. Schuss

**Occupant’s window opening and closing behaviour pattern in residential buildings**

830 Y. Pei*, J. S. Park
Field measurements of indoor particle matter concentration affected by indoor occupants' activities and outdoor conditions

M. J. Alonso, G. Cao*, H. M. Mathisen
ID124 Ventilation efficiency - D. Licina

Study on Microbial Contamination-Control of Evaporative Humidifier for Air Conditioning System using Electrolyzed Water (Part2)
57 K. Ikeda*, S. Nakai, K. Tamura

Experimental study on the impact of using a fan coil in the evaluation of ventilation efficiency of common air diffusion strategies
74 J. Monteiro*, O. Castro, A. Bathelt

Microorganisms spores inactivation by Photocatalysis in air handling unit

Single Coil Twin Fan Air-conditioning and Air Distribution System – Enhanced Air Exchange Effectiveness through DV and integrated Personalised Ventilation-UFAD strategies
159 C. Sekhar*, D. Kok Wai Cheong, K. Wai Tham, J. Juan Lim

Ventilation efficiency in a low-energy dwelling setting – a parameter study for larger rooms
180 D. Dijkstra, M. Loomans*, B. Cremers, J. Hensen

Investigation of an innovative perforated panel at real scale conditions
227 I. Nastase, A. Timpu, C. Croitoru*, A. Meslem

Exposure to aerosol and gaseous pollutants in a room ventilated with mixing air distribution
576 M. Bivolarova*, J. Ondrâček, V. Zdimal, A. Krikor Melikov, Z. Bolashikov

Actual Measurement and Analysis on Microbial Pollution in Central Air-conditioning System
631 Y. Lv*, C. yang Wang

Assessing Procedure for Measuring Ventilation Effectiveness in Mixing Ventilation: Experimental Study
674 H. Amai*, A. Novoselac

Evaluation of flush-out effect and energy cost in residential buildings
805 K. Lee*, K. Han Kim, J. Seok Park
Analysis of Contaminant Distribution in an Office Room with Liquid Cooling Air-conditioning System and Active Chilled beam

L. Wang*, S. Kato, H. Hwang
THURSDAY 16:00 - 17:00  UFO IV

ID82 IAQ hospital/office - A. Chamseddine

A source apportionment study on PM size distribution data collected in modern offices in Athens, Greece
411 D. Saraga*, I. Sakellaris, J. Bartzis

Modelling the fomite transmission of diseases in a hospital ward
474 S. Xiao*, Y. Li

Spatial variation of indoor air quality in hospitals: Impact of ventilation mode on potential exposure
514 A. Chamseddine*, M. El-Fadel, I. Alameddine

Behaviour of VOCS in a room in hospital
636 P. Pasanen*, P. Rautiainen, J. Ruokolainen, P. Saarinen, M. Hyttinen

The Hospital Wards Surface Cleanliness While Cleaning Of The Ventilation Systems
646 L. Kakko*, R. Holopainen

Indoor Air Quality Model evaluation in a modern office
717 D. Missia*, J. Bartzis, C. Dimitroulopoulou, I. Sakellaris, G. Efthimiou

Questionnaire study of indoor environment in two office buildings in Norway: one ordinary renovated and the other highly energy efficient renovated
774 J. Guan*, M. J. Alonso, H. M. Mathisen

Indoor aldehyde levels in different environments of Central Southern Spain
814 F. Villanueva*, B. Cabañas, E. Martinez, P. Martín, S. Salgado

Chemical Characterization of the Indoor Air Quality of a University Hospital: Contribution of Outdoor and Indoor Sources of Air Pollutants
1140 P. Scheepers*, L. van Wel, G. Beckmann, R. Anzion
ID78 Sensors - J. Langmans

Laboratory evaluation of two particulate matter sensors for their reliabilities
442 S. Won Kim*, S.-I. Kim, G. Hyun Lee, J. Young Park, K. Lee

Exploration of low-cost open source sensor technology to monitor the built environment in residential buildings
555 J. Meesters*, J. Langmans

Gas sensitive SiC-FET sensors for indoor air quality control
780 D. Puglisi*, M. Bastuck, M. Andersson, J. Huotari, J. Lappalainen, A. Schütze, A. Lloyd Spetz

Parallel Calibration of Low Cost Indoor PM2.5 monitors

Assessment of low-cost PM monitors for in-home wood smoke exposure study
913 A. Manikonda, N. Zikova, P. Hopke, A. R. Ferro*

Performances and limitations of electronic gas sensors to investigate an indoor air quality event: monitoring of VOC removal by a green wall
941 A. Caron*, P. Harb, N. Redon, F. Thevenet, P. Coddeville, B. Hanoune

Low-cost indoor air quality diagnoses for a fast characterization and localization of chemical pollutants in school buildings
977 J. Delahaye*, C. Levy, H. Buée, J. Georges des Aulnois
ID114 Emissions from consumer products - J. Little

Characterisation of VOC emissions released from furniture products
324 C. Leroux*, L. Verines, G. Boulanger, M.-L. Roux, C. Yrieix

Field campaign characterization of incense and candle emissions in indoor environment
414 M. Nicolas*, D. Buiron, E. Quivet, A. Albinet, G. Karr, F. Maupetit

Candles and incenses as indoor air fresheners: health risk assessment from real emission measurements
435 G. Karr, A. Albinet*, E. Quivet, D. Buiron, F. Maupetit, M. Nicolas

Determining the exposure factors of home and auto care products for exposure assessment
560 J. Young Park*, K. Lee, W. Yang, M. Lim, S. Park

Sampling and Analysis of Combustible Air Fresheners
608 C. Widdowson*

Reducing the formaldehyde emission in cooked Chinese medicine with Lycium by different ventilation rate and route
619 M.-C. Lee*, L.-H. Huang

Monitoring release of elemental mercury from compact fluorescent lamps in a control room at different point using three multipath-path atomic absorption spectrophotometer
827 A. Gioda*, S. Khan, A. Huaman De La Cruz, M. Fernanda Caceres, J. Mauricio Ceron Cifuentes, R. Aucelio

Chemical Exposures Related to Upholstered Furniture and Other Consumer Products
894 M. Black*, A. Davis, B. Ryan, D. Harris, S. Kerber

Development and optimization of a TD-GC/MS methodology for detection and quantification of furan released in air using of an experimental design. Study a furan diffusion in air
1204 Z. Alsafra, G. Scholl, V. Rocca, N. Molitor, A.-C. Romain*, G. Eppe
ID72 Cooking/burning - E. Carter

PM and VOCs determination from the combustion of untreated coals
669 M. L. Barabad*, W. Jung, M. Versoza, K. Lee, D. Park

Seasonal differences in the determinants of personal exposure to air pollutants among rural women cooking and heating with biomass fuels in the eastern Tibetan Plateau

Experimental study of indoor air quality in two types of Norwegian houses heated by wood stove
736 G. Cao*, L. Georges, Ø. Skreiberg, M. Seljeskog

Firewood use for residential purposes in Brazil: a case study
819 A. Gioda*

Influence of ultraviolet ray on oil mist concentration within an exhaust duct and analysis on chemical substance in oil mist during cooking
896 A. Okuda*, Y. Kondo, K. Hironori, Y. Machii, H. Yoshino, H. Komiyama

Air Quality Implications of Heating with Wood Stoves
989 P. Francisco, Z. Merrin*, N. Lam, T. Bond, R. Thompson, C. Weyant

Domestic combustion processes: mutagenicity assessment of aerosols
1014 N. Canha*, I. Lopes, E. Vicente, A. Vicente, S. Almeida, C. Alves

Attribution of air pollution from solid fuel to cooking and heating in Nepalese homes
1037 T. Bond*, N. Lam, R. Thompson, B. Upadhyay
ID129 Measurement techniques and health implications - P. Pasanen

QPCR - a rapid tool for determination of microbial contamination on building materials
156 H. Rintala*, M. Lindh, T. Meklin

A High Collection Efficiency Technique for Airborne Ultrafine – Bioaerosols
295 C.-C. Cheng*, Y.-P. Chen, Y.-C. Chen, K.-P. Yu

Indoor air toxicity assesment using E. coli-lux
620 E. Suominen*, J. Atosuo, E.-M. Lilius

Determining indoor bioaerosols using molecular techniques
632 N. Grydaki*, C. Whitby, I. Colbeck

The value of measurement of viable micro-organisms in analysing indoor air problems
649 G. Thierauf*, A. van Faassen

Analysis of Infection Spread with Agent Simulation based on Microbiome Measurement
1065 H. Nagano*, S. Kato, Y. U
4.6 Afternoon Keynotes

| 17:00-18:00 |
| UVO main auditorium |
KEYNOTE 3

Smart surfaces: self-cleaning titanium dioxide (TiO2) coatings for depollution purposes
Dimitris Kotzias - Ex-Official, JRC Institute for Health and Consumer Protection (IHCP)

TiO2-Photocatalytic materials and coatings when used as outer layer on buildings located in highly traffic roads have shown efficiency to degrade priority air pollutants (e.g. NO, NO2) originated from traffic exhausts.

In the last ten years, however, research was focused onto the application of smart photocatalytic materials and coatings, which could improve the quality of indoor environments too. In this context, a Mn-doped amorphous TiO2 photocatalyst powder was successfully applied for the oxidation of NO under indoor-like illumination conditions. After it was added to a calcareous matrix commonly used in the formulation of building products, the photocatalyst demonstrated its ability, in this form too, to degrade upon irradiation with visible light up to 95% of NO after 6h of irradiation, without any significant photocatalyst inactivation. Results from these experiments demonstrate that, with selection of both the appropriate dopant and its concentration, the photo-assisted elimination of air pollutants is a promising technique for remediation purposes in indoor environments.

The development of innovative building materials and coatings (containing TiO2) and, in particular, the development of catalysts activated by visible light are two fields of innovative research to be addressed in future investigations. Moreover, targeted studies addressing the efficiency of photocatalytic materials on the degradation of chemical mixtures including the determination of eventually formed, toxicologically relevant, by-products are needed in order to evaluate the applicability of these materials and coatings indoors.
KEYNOTE 4

From research to a product in a developing market
Catlin Powers - Co-Founder & CEO at One Earth Designs

Dr. Catlin Powers is the co-founder and CEO of One Earth Designs, recognized for its innovative solar energy technologies and high-performance SolSource Solar Stoves. Dr. Powers’ received her PhD from Harvard University. She is the recipient of the Marry White Peterson Prize for Innovation, the Camilla Chandler Frost Prize, and the St. Andrews Prize for the Environment. Her solar energy research has been recognized by the US National Science Foundation, U.S. Environmental Protection Agency, and American Institute of Chemical Engineers.
5 FRIDAY
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<td>Brunch networking</td>
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<td>9:30 - 10:30</td>
<td>Morning poster sessions</td>
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<td>10:30 - 11:30</td>
<td>Keynote awards</td>
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<td>Closing ceremony</td>
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| T2 | Chemistry                    |
| T3 | Ventilation/Thermal comfort  |
| T4 | Health                       |
| T5 | Modelisation                 |
| T6 | Energy/Sustainability/Design |
| T7 | Emission                     |
| T8 | Microbiology                 |
| T9 | Specific environments        |
| T10| Tools                        |
5.1 Morning posters
| 09:30-10:30
| UFO I-VIII
ID100 Physiological responses to temperature - M. Loomans

Experimental Study of elderly and youth’s thermal responses to temperature transient
66 C. Li, H. Yu*, M. Zhao, Z. Wang, Y. Yu

Experimental study about offset efficiency of air velocity on thermal comfort in warm environments
120 C. Du*

Optimum Indoor Thermal Comfort Conditions Required After Entering a Room from Outdoor Summer Heat
243 R. Matsuzaki*, E. Miyake, Y. Miyashita, S.-i. Tanabe

Impact of high humidity on thermal and humid responses of people in the hot-humid area
367 L. Jin*, Y. Zhang

Relationship between Indoor Temperature near the Floor and Winter Blood Pressure in Winter: A Multi-level Analysis
388 Y. Nakajima*, T. Ikaga, K. Kario, S. Ando, M. Kuwabara, S. Nakamura

Analytical method of solar radiation influence on thermal sensation accounting for transmission through clothing and clothing distribution
399 T. Sakoi*, S. Hosoya, Y. Kurazumi, T. Togami, H. Takita

The effect of high air temperature and high CO2 concentration on physiological responses and work performance
520 W. Liu*, P. L. Wargocki

Effect of acoustics, temperature and ventilation rate on performance
547 H. Koskela*, J. Varjo, A. Haapakangas, H. Maula, V. Hongisto, P. Kalliomäki

The influence of moderate heat stress on thermal comfort, motivation and mood at work places – a meta-analytic synthesis
749 S. Urlaub*, A. Steidle, G. Grün, K. Sedlbauer

The influence of moderate heat stress on performance - a meta-analytic synthesis
757 S. Urlaub*, A. Steidle, G. Grün, C. van Treeck, M. Denzler, K. Sedlbauer
Efficiency of Index ETVO for Evaluation of Indoor Thermal Environment with and without Solar Radiation
802 K. Nagano*, T. Horikoshi

Effects of solar heat load on the thermoregulatory responses of young and older men
1074 K. Tsuzuki*, I. Misaka, K. Narita, Y. Ishimaru
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<td><strong>Outdoor thermal bioclimatic environments and human behavior pattern</strong></td>
<td><em><em>B. Yang</em>, T. Olofsson</em>*</td>
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<td><em><em>A. Kabanshi</em>, S. Schiavon, S. Liu</em>*</td>
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<td><strong>ID85 School comfort and performance - F. Van Dijken</strong></td>
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ID118 IAQ, Infection and health effects - Y. Sun

An adenovirus 4 outbreak amongst staff in a paediatric ward manifesting as keratoconjunctivitis – a possible failure of contact and aerosol infection control
93 J. Tang*, E. Hoyle, J. Erez, H. Kirk-Granger, E. Collins

Associations between Indoor Environmental Damp and Cold Symptoms among Preschool Children in Shanghai, China
393 C. Sun*, C. Huang, Z. Zou, W. Liu, Y. Hu, L. Shen

Exposure Impact of Infection Routes: Droplet, Airborne, and Contact

Spread of Severe Acute Respiratory Syndrome (SARS) beyond Amoy Gardens
506 J. Wei*, Y. Li

Development of an indoor air quality index for risk assessment in hospitals
511 A. Chamseddine*, M. El-Fadel, I. Alameddine

Indoor Air Quality and Respiratory Health among Turkish Infants in Ankara, Turkey
850 S. Lakestani, G. Gullu*, S. Acar Vaizoglu, B. Guciz Dogan, B. Sekerel

Value of Health and Household Benefits Attributable to the Weatherization Assistance Program
854 B. Tonn*, E. Rose, B. Hawkins

Why Chinese children are sick in urban modern buildings-report from an ongoing study on associations between home environmental factors and health outcomes of children in Tianjin, China
881 Y. Sun*, J. Sundell

Health impact of indoor air chemical exposure on a multiple chemical sensitivity suspected patient: Case report study
893 H. Nakaoka*, N. Suzuki, T. Yamada, E. Todaka, C. Mori, A. Eguchi
ID115 Emission modeling and case studies - E. Goelen

Using the power-law model with short-term VOC emissions data from building materials to predict long-term emission characteristics

58 W. Ye*, D. Won, X. Zhang

An improved mass transfer model for simulating formaldehyde emissions from a medium-density fiberboard (MDF) in actual buildings

72 W. Liang*, X. Yang

Factors controlling volatile organic compounds in dwellings in Australia

91 M. Cheng*, I. Galbally, S. Molloy, P. Selleck, M. Keywood, S. Lawson, J. Powell, R. Gillett, E. Dunne

Analysis of Humidity and Carbon Dioxide Concentration to improve the Indoor Air Quality in Japanese Buildings

144 M. Hayashi*, H. Osawa, K. Hoon, Y. U, N. Kagi, N. Kahiara

Determining Convective Mass Transfer Coefficients in Indoor Semi-volatile Organic Compounds Fate Model for Realistic Buildings

270 X. Wang*, C. Luo, M. Zeng

Effect of ventilation rate on indoor air quality and energy performance of an office room made of hemp concrete


Characterization of mid- and long term emissions from building materials: impact of use and wear conditions

716 M. Nicolas*, B. D’Anna, A. Albinet, F. Maupetit, L. Chiappini
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<td>H. Zhang*, H. Yoshino</td>
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<td>A method to assess the outdoor thermal comfort around an elevated design building: Coupled CFD and onsite monitoring</td>
<td>J. Liu*, J. Niu, Q. Xia</td>
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<td>Effects of campus layout on outdoor thermal environment and of classroom forms on indoor thermal environment</td>
<td>S. Wen Mei*, L. Tzu-Ping, T. Ning-Xin, L. Mu-Hsien</td>
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<td>Analysis of the indoor thermal environment of Chongqing traditional stone houses in summer</td>
<td>M. Peng*</td>
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ID2017 What have we learned about buildings from the application of DNA-based methods? (Sloan) - J. Siegel

What are the implications for future research and practice?

Practical Uses of Indoor Microbiome Surveys: Informatics and Sequencing

258    K. Bibby*

Hospital Microbiome: lessons learned from combined building science and microbiology characterization

B. Stephens*

The IAQ practitioner and the indoor microbiome

J. Scott*
5.2 Morning keynotes
   | 10:30-11:30
   | UFO main auditorium
KEYNOTE 1

The State of Indoor Air Science
Charles J. Weschler - Rutgers University, Technical University of Denmark and Tsinghua University

In this presentation I will first describe what I consider to be among the more important drivers and advances in indoor air science since IA2014. These include the proliferation of low energy dwellings, which is forcing a re-examination of indoor sources of pollutants and ventilation strategies. Increased monitoring of manmade chemicals, or their metabolites, in blood and urine has led to a growing recognition of contributions from indoor exposure pathways, including dermal uptake directly from air. For certain chemicals found indoors, body fluid levels are being correlated with various adverse health effects. The proliferation of inexpensive wireless sensors is leading to innovative monitoring and targeted control of indoor environments. “Sustainable” building design now tends to recognize the importance of IAQ, although there is room for improvement. The complex dynamics of semivolatile organic compounds in indoor environments continues to be elucidated, and experimental methods are being devised to measure key parameters. A similar statement is true for indoor particles, especially ultrafine particles (UFP), and multiple intervention studies are using biomarkers to better elucidate the role of indoor PM in oxidative stress. We are witnessing startling advances in analytic capabilities. The sophisticated tools used to identify chemicals in outdoor air are coming indoors, thereby increasing our understanding of chemical transformations inside buildings. Gene sequence analysis has broadened our view of the microbes present in indoor air and on indoor surfaces, as well as where they come from. The indoor chemical environment continues to change -- both for the better (e.g., reductions in heavy metal toxicants and carcinogens) and the worse (e.g., increases in reproductive/developmental toxicants and endocrine disruptors). Our community is generating knowledge that is useful to other disciplines. Health scientists increasingly acknowledge that indoor exposures contribute to various adverse health effects. Epidemiologists appreciate that human intake of particles generated outdoors occurs primarily indoors. Manufacturers are paying greater attention to brominated flame retardants, phthalate ester plasticizers, perfluorinated surfactants and other additives in products intended for indoor use. Nonetheless, there remain many areas for improvement. These include greater participation of scientists from currently under-represented countries; better communication with health professionals; consideration of the
implications of climate change on a more localized level; improved knowledge of the chemicals we are using indoors and potential alternatives; attention to pollutants in hidden building cavities; and finally, a greater involvement in public health strategies designed to reduce risk from health damaging agents. While the state of indoor air science is strong, I envision a future in which it is even more vibrant and relevant than today.
5.3 Closing ceremony
| 11:30-12:30
| UFO main auditorium