International Association of Building Physics (IABP) Graduate Course
September 21-23, 2018 (2.5 days immediately before IBPC 2018)
Room 369, Link Hall, Syracuse University, Syracuse, NY 13244-1240, USA

Title: Coupled Heat, Air, Moisture and Pollutant Simulations in Built Environment Systems (CHAMPS-BES): Modeling VOC Emissions and Sorption of Building Materials

Course description: The course is intended for Ph.D. and M.S. students with prior knowledge of undergraduate levels of heat and mass transfer. It provides an in-depth discussion of the fundamental mechanisms and processes involved in the emissions of volatile organic compounds (VOCs) from building materials and indoor furnishings. Influencing factors to be considered will include the material properties (such as material composition, porosity, and specific surface area), chemical properties of the VOC species (such as the molecular weight and vapor pressure) and environmental conditions (such as air temperature, relative humidity, air velocity and concentrations). A coupled heat, air, moisture and pollutant simulation (CHAMPS) model will be introduced, detailing the governing equations, initial and boundary conditions, numerical scheme and interpretation of simulation results. Methods for the determination of the model parameters (diffusion and partition coefficients and initial VOC concentrations) will also be introduced, considering the emission characteristics of different building materials including "wet" coating, "wet" installation and dry materials. Several case studies, from simple to more complex ones will be used for in-class exercises to enhance the understanding of the fundamentals as well as developing practical modeling and simulation skills. The study cases will include selected common exercises of the IEA Annex-68 Indoor Air Quality in Low-Energy Residential Buildings. Participants are also encouraged to propose and define their own simulation cases based on their own research interests and topics. In addition, a small-scale VOC sorption and desorption (re-emission) experiment will be conducted as a group to introduce the test method and illustrate the test and data analysis procedure. A full-scale chamber experiment will be conducted to demonstrate the impacts of source control, ventilation and air cleaning on indoor VOC concentration levels. Participants should bring their own laptops for in-class room exercises in groups, while a computer room with 35 desktops will be available for use outside the classes.

Topics to be covered:

1. VOC emission and sorption characteristics of building materials and indoor furnishings and major influencing factors (By Jensen Zhang, 3 hours) – 9/21, 9:00 a.m.-12:00 p.m.
    a. Chamber testing methods and results for “wet” coating, installation and dry materials
    b. Mechanistic model-based testing and evaluation: principles and applications
2. A mechanistic model for coupled heat, air, moisture and pollutant simulations (By Prof. John Grunewald, 3 hr) – 9/21, 2:00 p.m.-5:00 p.m.
    a. Fundamentals
    b. Modeling and simulation with CHAMPS-BES/Delphin5
3. Material properties for heat, air, moisture and pollutant transfer and storage: a microscopic view and methods of determination (By Carsten Rode, 3 hr) – 9/22, 9:00 a.m.-12:00 p.m.
    a. Microscopic structure of materials and impacts on transport and storage properties
    b. Methods for the determination of the mechanistic model parameters
4. Computer simulation lab and experiments (By John Grunewald and Jensen Zhang, 6 hours) – 9/22, 2:00 p.m.-5:00 p.m. and 9/23, 9:00 a.m.-12:00 p.m.
    a. Modeling and simulation case studies* in groups with IAQX and CHAMPS-BES/Delphin (assisted by Zhenlei Liu and Dr. Meng Kong)
    b. Small and full chamber testing lab – Group experiments (assisted by Zhenlei Liu and Dr. Meng Kong)

Total contact hours: 15 hours, 2.5 days
Number of participants: 15-30

Instructors:

Dr. Jianshun (Jensen) Zhang, *Professor and Director, Building Energy and Environmental Systems Laboratory, Department of Mechanical and Aerospace Engineering, Syracuse University (SU), New York, USA. Dr. Zhang received his Ph.D. from University of Illinois at Urbana-Champaign in 1991, and was a Researcher at National Research Council of Canada for 8 years before he joined SU in 1999. His areas of expertise include: combined heat, air, moisture and pollutant simulations (CHAMPS); material emissions; air filtration/purification; ventilation; indoor air quality; and intelligent control of building environmental systems. He has developed advanced experimental methods and apparatus, computer simulation models and environmental control technologies. He has authored/co-authored over 100 peer-reviewed journal papers and over 100 refereed conference papers, and 3 standard methods for testing organic emissions from building materials and furnishing, including 2 ASTM and 1 ANSI/BIFMA standards. Dr. Zhang teaches both graduate and undergraduate courses in HVAC system design and analysis; building environmental systems measurements, control, modeling and simulations; and heat and mass transfer. He has advised/co-advised over 20 Ph.D. students and 10 Postdoctoral Fellows. He is Associate Editor of Journal of Science and Technology for the Built Environment and The International Journal of Ventilation, and served as a Member of the Editorial Board of Building Simulations—an international Journal, International Journal of High-Rise Buildings, and the International Journal of Architectural Frontiers. He is Fellow of ASHRAE and ISIAQ, and a Board Member of the International Association of Building Physics.*

Dr. John Grunewald, *Professor and Director, Institute of Building Climatology, Dresden University of Technology, Germany. Dr. Grunewald received his Ph.D. from Dresden University of Technology in 1997, and was a Research Associate Professor at Syracuse University, NY, Department of Mechanical and Aerospace Engineering, USA before he joined Dresden University of Technology in 2007. His areas of expertise include: Preservation of historical buildings - cultural heritage, sustainable development of built environment, New materials and processes – mechanical and building physical properties, durability, damaging processes, Interaction of Building – Climate – Inhabitants, Health and comfort, Emission of pollutants. He has developed advanced computer simulation models for heat and mass transfer in porous building materials. He has authored/co-authored over 50 peer-reviewed journal papers and over 80 refereed conference papers. Dr. Grunewald teaches both graduate and undergraduate courses in building physics; modeling and simulations; and heat and mass transfer. He has advised/co-advised over 10 Ph.D. students. He is Chairman of the Examination Board of the Faculty of Architecture, Chairman of the Center for Building Research (ZfBau) of the TU Dresden, and Chairman of the Board of IBPSA Germany, Regional Affiliate of the International Building Performance Simulation Association (IBPSA).*

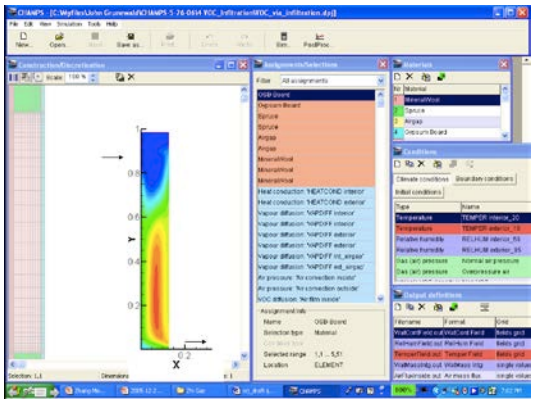
Dr. Carsten Rode, *Professor, Hygrothermal Building Physics, Department of Civil Engineering, Technical University of Denmark. He holds an M.Sc. in civil engineering (1987), and a Ph.D. in building physics (1990). He is a specialist in heat, air and moisture transport in buildings, including the indoor environment, and is an expert in energy performance of buildings. He has experience from participation in several international research projects, e.g. within the IEA, related to the performance of energy efficient buildings. Prof. Rode is past president of the International Building Physics Association (2009-2015), and is Operating Agent of the International Energy Agency research project under the Energy in Buildings and Communities Programmme: Annex 68, Design and Operational Strategies for High IAQ in Low Energy Buildings (2015-2018). He also leads a Work Package on Intelligent Energy Systems Integration in the strategic Research Centre, CITIES, Center for IT-Intelligent Energy Systems in Cities (2014-2019), and is responsible for research in a subtask on Smart Energy Buildings in the Danish Energy Agency Research and Development Project EnergyLab Nordhavn (2015-2019). Furthermore, Prof. Rode is engaged in projects on energy renovation of existing buildings, such as the EU Horizon 2020 project RIBuild.*

Venus and facilities:

Syracuse University Main Campus

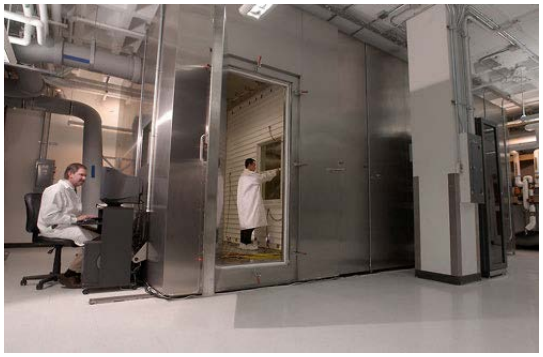
The Quad view from Link Hall

369 Link Hall – Collaborative classroom



CHAMPS-BES simulation of VOC infiltration

374 Small-scale environmental chambers



320 Link Hall – Full-scale coupled environmental chambers

Course fees: $150 (including a USB containing the course presentations, reference materials and software to be used)

Contact: Dr. Meng Kong, BEESL, Department of Mechanical and Aerospace Engineering, College of Engineering and Computer Science, Syracuse University. Email: mkong01@syr.edu.