Session IV-A: Indoor Environment II

Tuesday, December 7, 2004
8:30 a.m. to 10:00 a.m.
Grand Ballroom – Beach

Session Chair:

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8:30 a.m. to 8:40 a.m. Introduction
Achilles Karagiozis

8:40 a.m. to 9:00 a.m. *"Potential for Hygroscopic Building Materials to Improve Indoor Comfort and Air Quality in the Canadian Climate"*
Carey Simonson

9:00 a.m. to 9:20 a.m. *"Moisture Buffer Performance of a Fully Furnished Room"*
Kaisa Svennberg

9:20 a.m. to 9:40 a.m. *"Moisture Buffer Capacity of Different Insulation Materials"*
Ruut Peukhuri

9:40 a.m. to 10:00 a.m. *"Moisture Buffering Effects on Indoor Air Quality—Experimental and Simulation Results"*
Mikael Salonvaara

Potential for Hygroscopic Building Materials to Improve Indoor Comfort and Air Quality in the Canadian Climate

Carey Simonson and Stephen Olutimayin – *University of Saskatchewan*

Tuomo Ojanen and Mikael Salonvaara – *VTT Building and Transport*

Jennifer O'Connor – *Forintek Canada Corporation*

This paper presents a numerical investigation of the indoor conditions in a bedroom in a wooden building located in Saskatoon, Vancouver, and Toronto, Canada. Based on correlations from the literature, which quantify the effect of temperature and humidity on warm respiratory comfort and perceived indoor air quality for sedentary adults, the results indicate that hygroscopic materials have a good potential to improve comfort and air quality in Canadian residences. However, the application of hygroscopic materials will not ensure acceptable indoor conditions and during some weather conditions (typically less than 10% of the time) hygroscopic materials may slightly degrade the indoor conditions. At a ventilation rate of 0.5 ach, it is possible to improve the indoor conditions in each climate studied such that as many as 10 people out of 100 are satisfied with the thermal comfort conditions (warm respiratory comfort) at the end of occupation. Similarly, the percent dissatisfied with perceived air quality can be 20% lower in the morning when permeable and hygroscopic structures are applied. On average, the reduction in percent dissatisfied with comfort and air quality at the end of occupation is 2% and 4%, respectively, when the outdoor ventilation rate is 0.5 ach. When the ventilation rate increases to 1 ach, the differences between the hygroscopic and nonhygroscopic cases decreases.

Moisture Buffer Performance of a Fully Furnished Room

Kaisa Svennberg – *Lund Institute of Technology*

Lone Hedegaard and Carsten Rode – *Technical University of Denmark*

The moisture buffer capacity of hygroscopic materials can be used to moderate the relative humidity of indoor air as well as moisture content variations in building materials and furnishing. Since moisture plays a significant role in the development of many processes that affect the quality of the indoor air, such as growth of house dust mites, emissions from materials, and mold growth, it is anticipated that the moisture buffer effect can help to ensure healthier indoor environments.

Building materials, as well as furniture and other furnishing materials exposed to indoor air, will contribute to the moisture buffer capacity of rooms. Few studies have been made on the impact of furnishing materials in comparison with traditional building materials. This paper will present such a study conducted in a full-scale climatic test cell.

A series of experiments have been carried out in the test cell to show the moisture buffer performance of various furnishing objects. The objects will be exposed to cyclic humidity variations as in an inhabited indoor environment, and the response of the indoor humidity will be followed over time. It will be a step-by-step investigation starting with an empty room and going toward a fully furnished room. Comparisons are made with previous studies covering traditional building materials and calculations.

The study shows that the furnishings have to be included in the understanding of the moisture buffering performance of a room and that more material data in this area is needed.

Moisture Buffer Capacity of Different Insulation Materials

Ruut Peuhkuri, Carsten Rode, and Kurt Kielsgaard Hansen – *Technical University of Denmark*

There is an increasing focus on the possibilities of utilizing the absorptive ability of porous materials to create passive control of humidity variations in the indoor air. These variations result in peaks in the indoor air humidity due to moisture production or in the exterior building envelope due to the diurnal variations of outdoor air temperature and humidity. Passive control of the humidity of the indoor air—particularly together with passive thermal control—may lead to smaller energy use for climatization of buildings. For exterior envelopes, the choice of the right materials can lead to more durable constructions.

This paper describes the testing of a large range of very different thermal insulation materials in specially constructed laboratory facilities to determine their moisture buffer capacity. Both isothermal and non-isothermal experimental setups have been used. In the isothermal tests the material samples were exposed to the same change in the relative humidity of the ambient air on both sides, while the samples were exposed to variations in relative humidity only on the cold side in the non-isothermal tests.

The results of these rather different measurement principles are discussed, and different ways are presented to determine the moisture buffer capacity of the materials using partly standard material parameters and partly parameters determined from actual measurements.

The results so far show that the determination of moisture buffer capacity is very sensitive to the method of analysis used and, therefore, great care has to be taken when comparing results of different experiments. The paper discusses this issue and recommends a simple and consistent way to present the moisture buffer capacity of the materials in contact with the indoor air on the basis of experimental results.

Moisture Buffering Effects on Indoor Air Quality—Experimental and Simulation Results

Mikael Salonvaara and Tuomo Ojanen – *VTT Building and Transport*

Andreas Holm and Hartwig M. Küenzel – *Fraunhofer Institute for Biophysics*

Achilles N. Karagiozis – *Oak Ridge National Laboratory*

The ability of building materials to control indoor air humidity is studied in this paper. First, moisture capacity and transient response of building materials were investigated in small-scale laboratory experiments. Effects of moisture-absorbing interior wall materials on indoor air humidity were measured in a full-scale room under controlled conditions with known ventilation rates and moisture production schedule. The measured interior surface materials included wood, porous wood fiberboard, gypsum board with hygroscopic insulation, perforated plywood board, and, in a reference case, aluminum foil. Second, numerical simulation tools for hygrothermal performance analyses of building envelope parts and for buildings as a whole were used to assess the impact of hygroscopic mass on indoor air humidity. Two levels of testing and simulation were carried out: First, the moisture capacity of building materials in dynamic conditions was tested in small-scale laboratory tests. Second, the materials were placed in a room with intermittent moisture production. Moisture production and ventilation rates were set to correspond to those typical in residential buildings. Mass transfer between the finishing materials and indoor air affects the humidity both in indoor air and in the building envelope. The effect of coatings and their vapor permeance on the moisture exchange was investigated. A sensitivity study looking at the hygrothermal material properties and their effects on the performance was carried out.