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Indoor Air 2011 -- I2P2 Program a Great Success

By Don Weekes, (former ISIAQ Director)

The Innovations to Practice Program (I2P2) at Indoor Air 2011 in Austin was a great success, according to the many attendees who were both practitioners and researchers. For many IAQ practitioners, Indoor Air 2011 was their first opportunity to meet the researchers and academics that have written the seminal research articles on indoor air quality issues such as microbial contamination; weatherization and IAQ; infectious diseases; nanoparticles; ventilation and health; and some many other topics.

The I2P2 program was integrated into the overall IA2011 program so that all attendees could listen to presentations on a variety of topics that relate to both to IAQ practice and to the research agenda on indoor air quality. There were also workshops where practitioners and researchers answered questions presented by each other as well as questions from the audience. These sessions were very well attended, and the participants found that there was knowledge to be shared from both parties.

IA2011 President Rich Corsi said: "My sense is that practitioners felt more at home at this research-focused conference than any others in the past, that they got a lot out of it, and that we might have started something important (I hope that we can make it last)."

IA2011 Co-Chair – Practice Don Weekes said: "From the practitioners that I talked to during, and after, the conference, they were very pleased with the conference and the reception they received from the research community. I do believe that the interaction between the two groups was very helpful, and I think that there will be future interactions that will be fruitful for both sides."

On IAQ Radio, host Joe Hughes and IAQA President Carl Grimes, both first-time attendees to an Indoor Air conference, shared their experiences and told the audience about the sessions they particularly enjoyed. This session can be heard at:
http://www.talkshoe.com/talkshoe/web/audioPop.jsp?episodeId=496988&cmd=apop

For future Indoor Air and Healthy Building conferences, it is hoped that a practitioner track will be a priority so that the momentum established at IA2011 can be maintained.

Note: A strong indicator of the success of the I2P2 program: IAQA Members who registered for IA2011 received a $50 discount off the registration fee. After the conference, almost all of them accepted ISIAQ's one time, special offer of membership for $50. This suggests that the practitioners are interested in and value good scientific content, a strong theme throughout ISIAQ's 20-year history. [Hal Levin, ISIAQ Administrator.]

In this Issue

Indoor Air 2011 Proceedings, now available on flash drive

For those of you missed the highly acclaimed Indoor Air 2011 conference in Austin, TX, ISIAQ is pleased to offer you the Indoor Air 2011 Proceedings on flash drive.

The Indoor Air 2011 Proceedings flash drives are available to members for the low price of $25 including shipping. The Proceedings are available to non-members for $99.

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RESEARCH NEWS

Stove sensor project takes top prize in Vodafone competition for wireless innovation

In a world where millions of simple stoves contributing to climate change and premature deaths are being replaced by lower-emission alternatives, individual household visits to evaluate the success of the interventions are simply out of the question. The method of measurement—vital to the continuing development of these lifesaving programs—needs to be low-cost, accurate, sustainable, and scalable.

A groundbreaking "stove use monitoring system" (SUMS) developed at UC Berkeley won the first-place $300,000 prize in the 2010 Vodafone Americas Foundation Wireless Innovation Project, which selects three wireless projects with the potential to save lives and solve critical global challenges. The three winners were chosen from a pool of nearly 100 qualified applicants from universities and nongovernmental organizations from throughout the United States.

The *100 Million Stoves* device is a simple wireless SUMS, powered with the excess heat of the stove, which can be attached to the millions of new low-emission stoves being used in developing regions. The device will record usage data and send them to a dedicated reader carried by someone in the village making a monthly walk through. The cumulated data will then be uploaded via cell phone to a central database for systematic processing. The low-cost technology will allow the assessment of household energy programs, enable feedback from users, and provide transparent verification of carbon credits.

"The wireless SUMS can be deployed in a careful subsample across millions of households in a statistically valid manner," says Professor of Global Environmental Health Kirk R. Smith, who leads the UC Berkeley research team at the School of Public Health. "Unlike household visits, the monitors provide unique and valuable information that can be scaled to millions."

The *100 Million Stoves* team consists of Smith's research group, three small Berkeley companies—BioLite, Electronically Monitoring Ecosystems, and Berkeley Air Monitoring Group—and the Department of Environmental Health Engineering at Sri Ramachandra University in Chennai, India. Together they have built prototypes of the wireless SUMS, and the Vodafone award will help bring the project to the next stage of implementation and scale. The team plans to use the device in trials and its initial application will be in India as part of the country's National Biomass Cook-stoves Initiative.

"Soon it will be ready for use by groups around the world wishing to validate carbon credits for stove programs on the international carbon market," says Smith. "In addition, it can also serve as the basis for other devices to remotely and efficiently monitor the use and effectiveness of household health and energy interventions for research, program evaluation, and user feedback."

More information about the Vodafone Americas Foundation Wireless Innovation Project, *100 Million Stoves*, and the other two prize-winning projects is available online at: http://project.vodafone-us.com/winners-2010-stoves.html.

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Abstracts

William W Nazaroff - Norovirus, gastroenteritis, and indoor environmental quality

Recently, I began reviewing the literature on indoor bioaerosol dynamics. Using ISI's Web of Knowledge, I compiled a bibliography of about 400 articles. I printed the abstracts, assembled them alphabetically, and started reading. However, I only got as far as 'B' before becoming sidetracked in reaction to a comment by Beggs and Kerr (2000) that surprised me: '… it is now evident that the airborne route is a significant mode of spread in outbreaks of acute viral gastroenteritis.' Whoa! I'm aware that airborne transmission is key for tuberculosis, measles, and chickenpox and also strongly suspected to play a significant role for influenza, rhinovirus, and severe acute respiratory syndrome (SARS) (Li, 2011). But viral gastroenteritis? Isn't that issue entirely in the domains of water quality, sanitation, personal hygiene, and food safety? How could airborne transmission play an important role? And, if airborne transmission was indeed significant (combined with the reasonable expectation that such transmission would mainly occur indoors), then would this topic not lie well within the scope of *Indoor Air*?

W. J. Fisk, D. Black and G. Brunner - Benefits and costs of improved IEQ in U.S. offices

Abstract This study estimates some of the benefits and costs of implementing scenarios that improve indoor environmental quality (IEQ) in the stock of U.S. office buildings. The scenarios include increasing ventilation rates when they are below 10 or 15 l/s per person, adding outdoor air economizers and controls when absent, eliminating winter indoor temperatures >23°C, and reducing dampness and mold problems. The estimated benefits of the scenarios analyzed are substantial in magnitude, including increased work performance, reduced Sick Building Syndrome symptoms, reduced absence, and improved thermal comfort for millions of office workers. The combined potential annual economic benefit of a set of nonoverlapping scenarios is approximately $20 billion. While the quantitative estimates have a high uncertainty, the opportunity for substantial benefits is clear. Some IEQ improvement measures will save energy while improving health or productivity, and implementing these measures should be the highest priority.

Practical Implications Owners, designers, and operators of office buildings have an opportunity to improve IEQ, health, work performance, and comfort of building occupants and to obtain economic benefits by improving IEQ. These benefits can be achieved with simultaneous energy savings or with only small increase in energy costs.

M. Täubel, M. Sulyok, V. Vishwanath, E. Bloom, M. Turunen, K. Järvi, E. Kauhanen, R. Krska, A. Hyvärinen, L. Larsson and A. Nevalainen - Co-occurrence of toxic bacterial and fungal secondary metabolites in moisture-damaged indoor environments

Abstract Toxic microbial secondary metabolites have been proposed to be related to adverse health effects observed in moisture-damaged buildings. Initial steps in assessing the actual risk include the characterization of the exposure. In our study, we applied a multi-analyte tandem mass spectrometry-based methodology on sample materials of severely moisture-damaged homes, aiming to qualitatively and quantitatively describe the variety of microbial metabolites occurring in building materials and different dust sample types. From 69 indoor samples, all were positive for at least one of the 186 analytes targeted and as many as 33 different microbial metabolites were found. For the first time, the presence of toxic bacterial metabolites and their co-occurrence with mycotoxins were shown for indoor samples. The bacterial compounds monactin, nonactin, staurosporin and valinomycin were exclusively detected in building materials from moist structures, while chloramphenicol was particularly prevalent in house dusts, including settled airborne dust. These bacterial metabolites are highly bioactive compounds produced by *Streptomyces* spp., a group of microbes that is considered a moisture damage indicator in indoor environments. We show that toxic bacterial metabolites need to be considered as being part of very complex and diverse microbial exposures in 'moldy' buildings.

Practical Implications Bacterial toxins co-occur with mycotoxins in moisture-damaged indoor environments. These compounds are measurable also in settled airborne dust, indicating that inhalation exposure takes place. In attempts to characterize exposures to microbial metabolites not only mycotoxins but also bacterial metabolites have to be targeted by the analytical methods applied. We recommend including analysis of samples of outdoor air in the course of future indoor assessments, in an effort to better understand the outdoor contribution to the indoor presence of microbial toxins. There is a need for a sound risk assessment concerning the exposure to indoor microbial toxins at concentrations detectable in moisture-damaged indoor environments.

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L. Lan, P. Wargocki, D. P. Wyon and Z. Lian - Effects of thermal discomfort in an office on perceived air quality, SBS symptoms, physiological responses, and human performance

Abstract The effects of thermal discomfort on health and human performance were investigated in an office, in an attempt to elucidate the physiological mechanisms involved. Twelve subjects (six men and six women) performed neurobehavioral tests and tasks typical of office work while thermally neutral (at 22°C) and while warm (at 30°C). Multiple physiological measurements and subjective assessment were made. The results show that when the subjects felt warm, they assessed the air quality to be worse, reported increased intensity of many sick building syndrome symptoms, expressed more negative mood, and were less willing to exert effort. Task performance decreased when the subjects felt warm. Their heart rate, respiratory ventilation, and end-tidal partial pressure of carbon dioxide increased significantly, and their arterial oxygen saturation decreased. Tear film quality was found to be significantly reduced at the higher temperature when they felt warm. No effects were observed on salivary biomarkers (alpha-amylase and cortisol). The present results imply that the negative effects on health and performance that occur when people feel thermally warm at raised temperatures are caused by physiological mechanisms.

Practical Implications This study indicates to what extent elevated temperatures and thermal discomfort because of warmth result in negative effects on health and performance and shows that these could be caused by physiological responses to warmth, not by the distraction of subjective discomfort. This implies that they will occur independently of discomfort, i.e. even if subjects have become adaptively habituated to subjective discomfort. The findings make it possible to estimate the negative economic consequences of reducing energy use in buildings in cases where this results in elevated indoor temperatures. They show clearly that thermal discomfort because of raised temperatures should be avoided in workplaces.

S.-C. Weng, W. A. Weaver, M. Zare Afifi, T. N. Blatchley, J. S. Cramer, J. Chen and E. R. Blatchley III - Dynamics of gas-phase trichloramine (NCl3) in chlorinated, indoor swimming pool facilities

Abstract Trichloramine (NCl_3) is recognized as an irritant of the human respiratory system and other tissues. Processes that lead to volatilization from the liquid phase allow for human exposure to gas-phase NCl_3 in swimming pool settings. The dynamics of these processes are not well defined. A *N*,*N*-diethyl-*p*-phenylenediamine/potassium iodide (DPD/KI)-based wet-chemistry method for measuring gas-phase NCl_3 concentration was verified and applied in chlorinated, indoor swimming pool facilities. Other gas-phase oxidants in the air of indoor pools provided interference of 15% or less. The DPD/KI method was applied for the measurement of gas-phase NCl_3 in four chlorinated, indoor swimming pool facilities. All results showed a correlation between bather loading and gas-phase NCl_3 concentration. The nature of swimmer activities also influenced air quality, presumably because of the effects of these activities on mixing near the gas–liquid interface.

Practical Implications The activities of swimmers promote transfer of volatile compounds from water to the surrounding air. For chlorinated, indoor pool facilities, this can lead to exposure to gas-phase chemicals that can cause irritation of the respiratory system and other tissues. The focus of this study was on NCl_3, a common disinfection by-product (DBP) in chlorinated pools. However, the conditions that promote NCl_3 transfer are likely to promote transfer of other volatile chemicals from water to air. As such, it is possible that other DBPs formed in pools may also contribute to diminished air quality.

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C. D. Forester and J. R. Wells - Hydroxyl radical yields from reactions of terpene mixtures with ozone

Abstract Chamber studies were conducted to quantify hydroxyl radical ($OH^{\cdot}$) yields and to determine whether water vapor affected $OH^{\cdot}$ formation in the reactions of ozone (O_3) with a single terpene, two-component terpene mixtures, and a commercial pine oil cleaning product (POC). Solid-phase microextraction fibers (SPME) were used for sampling the terpenes and the 2-butanone formation from the hydroxyl reaction with 2-butanol as a measure of $OH^{\cdot}$ yields. Analyses were performed using gas chromatography with flame ionization detection. The individual terpenes' $OH^{\cdot}$ yields from α-terpineol, limonene, and α-pinene were 64 ± 8%, 64 ± 6%, and 76 ± 6%, respectively. $OH^{\cdot}$ yields were also measured from two-component mixtures of these terpenes. In each mixture that contained α-terpineol, the overall $OH^{\cdot}$ yield was lower than the modeled $OH^{\cdot}$ yields of the individual components that comprised the reaction mixture. Reactions of a commercial POC with O_3 were also studied to determine how the individual terpenes react in a complex mixture system, and an $OH^{\cdot}$ formation yield of 51 ± 6% was measured. Relative humidity did not have a significant effect on the $OH^{\cdot}$ formation in the mixtures studied here.

Practical Implications The data presented here demonstrate that mixtures may react differently than the sum of their individual components. By investigating the chemistry of mixtures of chemicals in contrast to the chemistry of individual compounds, a better assessment can be made of the overall impact cleaning products have on indoor environments.

G. Firdaus and A. Ahmad - Indoor air pollution and self-reported diseases – a case study of NCT of Delhi

Abstract People in modern societies often spend 80–90% of their time in indoor environments. It is, therefore, imperative to analyze indoor air quality (IAQ) and its determinants and to consider the contribution of IAQ to possible health outcomes at the household level. Based on empirical data collected from 5949 households from 35 wards of Delhi, it can be summarized that higher proportions of residents live in degraded indoor environmental conditions. The highest risks to health were attached to use of traditional fuels (64%), lack of a kitchen (59%), exposure to environmental tobacco smoke (ETS) (55%), and poor ventilation (55%). Acute respiratory infections (43%) were identified as one of the most prevalent health problems confronted by residents and are strongly associated with use of traditional fuels (adjusted OR 2.7, 95% CI 2.3–3.1). Asthma shows a significant relationship with the use of traditional fuels (adjusted OR 3.8, 95% CI 3.4–4.3), exposure to ETS (adjusted OR 2.5, 95% CI 2.2–2.7), and poor ventilation (adjusted OR 1.26, 95% CI 1.13–1.41). Lung cancer (adjusted OR 1.54, 95% CI 1.38–1.71) and cardiovascular diseases (adjusted OR 2.25, 95% CI 2.01–2.53) also show a strong relationship with ETS exposure. More research is needed.

Practical Implications The present study can help to create new insights in understanding the gravity of indoor air quality problems in Delhi and can therefore provide interesting material to social scientists, public health officers, planners, and decision makers. The information can be utilized to help formulate comprehensive policies and planning with a humanistic approach for proper urban indoor environments that will be applicable at all administrative levels, viz. local, national, and international, and will also provide an important background for additional research in this area.

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S. J. Cho, J.-H. Park, K. Kreiss and J. M. Cox-Ganser - Levels of microbial agents in floor dust during remediation of a water-damaged office building

Abstract We examined the effects of remediation on loads of culturable fungi in floor dust collected from a large water-damaged office building during four cross-sectional surveys (2002, 2004, 2005, and 2007, respectively). We created a binary remediation variable for each year for each sampled workstation using information on remediation associated with water damage obtained from building management and used generalized linear mixed-effects models. We found significantly lower levels of culturable total and hydrophilic fungi at remediated workstations than at non-remediated workstations in 2004 and 2005 after completion of major remediation. The remediation effect, however, disappeared in 2007. The fraction of hydrophilic to total fungal concentrations was lowest in 2004, increased in 2005, and was highest in 2007. Our results indicate that the 2003 remediation lowered dust indices of dampness temporarily, but remediation was incomplete, consistent with a building assessment report of water infiltration. This study demonstrates the utility of longitudinal evaluation of microbial indices during remediation of water damage in this building, in which elimination of sources of moisture was not fully addressed. Our findings indicate that the fraction of hydrophilic fungi derived from concentrations of fungal species may be a useful index for assessing the long-term effectiveness of remediation.

Practical Implications This study demonstrates the utility of longitudinal evaluation of microbial indices during remediation of water damage in this building, in which elimination of sources of moisture was incomplete. Our findings indicate that the fraction of hydrophilic fungi derived from concentrations of fungal species may be a useful index for assessing the long-term effectiveness of remediation.

D. Norbäck, G. Wieslander, X. Zhang, and Z. Zhao - Respiratory symptoms, perceived air quality and physiological signs in elementary school pupils in relation to displacement and mixing ventilation system: an intervention study

Abstract Schools may be poorly ventilated and may contain furry pet allergens, particles and microorganisms. We studied health effects when changing from mixing ceiling ventilation to two types of displacement ventilation, front ventilation system (FVS) and floor master system (FMS). The study included pupils in three elementary school classes (N = 61), all with floor heating. One class received blinded interventions; the two others were unchanged (controls). Ventilation flow and supply air temperature was kept constant. The medical investigation included tear film stability (BUT), nasal patency and a questionnaire containing rating scales. When changing from mixing ventilation to FVS, the pupils (N = 26) perceived better air quality (P = 0.006) and less dyspnoea (P = 0.007) as compared to controls (N = 35), and BUT was improved (P = 0.03). At desk level, mean CO2 was reduced from 867 to 655 ppm. Formaldehyde and viable bacteria were numerically lower, while total bacteria and molds were higher with displacement ventilation. There was no difference in symptoms or signs when changing from FVS to FMS. Cat (Der p1), dog (Can f1) and horse allergen (Equ cx) were common in air at all conditions. In conclusion, displacement ventilation may have certain positive health effects among pupils, as compared to conventional mixing ceiling systems.

Practical Implications Displacement ventilation may be a suitable ventilation principle for achieving good indoor environment in classrooms. The type of supply air diffuser does not seem to be of major importance. The combination of floor heating and displacement ventilation can be a useful way of avoiding the previously described problem of thermal discomfort.

About ISIAQ

With more than 900 members from more than 45 countries, ISIAQ is an international, independent, multidisciplinary, scientific, non-profit organization whose purpose is to support the creation of healthy, comfortable and productive indoor environments. We strongly believe this is achievable by advancing the science and technology of indoor air quality and climate as it relates to indoor environmental design, construction, operation and maintenance, air quality measurement and health sciences.

As a Society, our major role is to facilitate international and interdisciplinary communication and information exchange by publishing and fostering publication on indoor air quality and climate. We organize, sponsor and support initiatives such as meetings, conferences, and seminars on indoor air quality and climate; and we develop, adapt and maintain guidelines for the improvement of indoor air quality and climate.

ISIAQ's journal, *Indoor Air*, published six times per year, is the most respected and widely-cited source of scientific information relevant to building scientists and professionals. Our two major international conferences -- the Indoor Air 'xx and the Healthy Buildings 'xx conference series -- set the standard for high quality scientific information and its application to making healthy buildings. We also cooperate with government and other agencies and societies with interests in the indoor environment and climate.

To find out more about us, visit our website: http://isiaq.org

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