New Directions for IAQ

Finding Opportunities in Smartphones, Green Buildings and Phthalates

BY DON WEEKES

"Is there a future in indoor air quality consulting?" This question has come up frequently at recent industrial hygiene conventions and conferences, and it's particularly relevant for those of us who have been in the field for the long term. Since the financial crisis hit in 2008, the number of news articles about indoor air quality has decreased discernibly. Also, the market has matured in the past few years: many companies and "five-day wonders" (individuals who take a five-day course in IAQ or mold without past knowledge or experience in the field) who entered the field during the "mold is gold" era have shifted into other areas with clearer opportunities for growth, such as energy auditing. IAQ consulting has also been affected by new measures that building managers and owners are taking to prevent IAQ problems and complaints before they occur.

Even with these shifts, there are still many opportunities to provide quality IAQ technical services to clients in need of assistance. For example, there are three areas in which industrial hygiene practice and indoor air quality work is growing: smartphones, green buildings and phthalates.

IAQ's Beginnings

Indoor air quality consulting has been a specialty within the industrial hygiene field since the late 1970s. The energy crises of that decade led to a peak in the price of heating oil. To save energy and money, building owners and managers cut back on the airflow of heated and cooled air into their buildings. At times, these cutbacks were supported by changing government requirements in

the name of "saving energy." Some of the guidelines and standards issued by professional organizations, such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), also supported the reduction of airflow per occupant. Because of these changes in airflow and temperature (and sometimes relative humidity), some occupants in these buildings began to complain about the "indoor air"—that it was too hot or too cold.

Many of these complaints were addressed to in-house health and safety personnel. These individuals often were trained consultants to industrial facilities that followed standards (OSHA's permissible exposure limits, or PELs) and guidelines (ACGIH's threshold limit values, or TLVs) for airborne contaminants. Collecting personal air samples on industrial workers was the standard procedure for evaluating the potential for employee exposures. However, these standards and guidelines often proved inadequate for addressing office workers' IAQ complaints. Pioneering industrial hygienists then developed new methods and techniques to address these complaints that put less emphasis on personal air sampling. For example, industrial hygienists used IAQ questionnaires to help pinpoint occupants' adverse health symptoms and when these symptoms were prevalent. Detailed and thorough visual inspections of offices located potential sources of odors that triggered health symptoms and complaints. Some of these IHs formed the AIHA® Indoor Environmental Quality (IEQ) Committee in 1983.

This new IAQ practice developed over the next 25 years as IAQ practitioners moved on to other areas where occupants' complaints were prevalent, including consulting for homeowners and addressing issues such as microbial contamination. The field diversified as individuals other than industrial hygienists entered the profession to handle the increasing number of reported problems related to IAQ. A number of related professions developed over the same time period—especially mold remediation. In 1995, the Indoor Air Quality Association (IAQA) was formed to provide an organization for individuals and companies with an interest in IAQ and related fields.

The Rise of Smartphones

According to mobithinking.com, there are currently 6 billion mobile phone subscriptions worldwide—a number that covers 87 percent of the world's population—and 1.1 billion smartphones in use, including 701 million in developed nations and another 484 million in developing nations. Experts predict that mobile web usage will overtake PC-based web usage in the near future and that this will happen more quickly in developing nations.[1]

The potential use of mobile phones—particularly smartphones—for the monitoring of environmental conditions in the workplace has drawn the interest of several IAQ professionals and academics, including Drs. Robert Steele and Andrew Clarke of the University of Sydney in Australia. In a recent presentation at the Healthy Buildings 2012 conference, the professors discuss what they call a "person-centric" approach to data collection for healthy buildings. As noted in their paper:

> This approach differs from previous models that involved using sensors/wireless sensor networks (WSNs) to measure environmental variables or that of collecting subjective perceptions of the environment via surveys or similar means from occupants. The participatory sensing model discussed in this paper allows for a real-time combination of personal sensing and sensing device information to provide a composite measure of building health.[2]

The advantage of collecting IAQ parameters from individual cell phones or smartphones is that the sampling data would constitute continuous real-time monitoring of the indoor environment wherever the cell phone wearer is located. This real-time IAQ data would be fed back to a building automation system that could adjust the indoor air parameters in the area where the individual is located. This is different from other methods that propose to monitor the indoor environment by a fixed-infrastructure network of sensors alone, which would provide a high level of spatial accuracy but limit the sensor's mobility. Steele and Clarke propose "a composite model that allows the collection of both fixed-infrastructure sensor-based data and person-centric data collection through mobile devices."[2]

Finally, Steele and Clarke note that smartphones could allow building occupants, through one-way data sharing with health information systems, "to further extend their electronic health record, while the inherent provisions for privacy and research platforms could bring further meaning to the collected data, in regards to long-term effects of indoor environments."[2] This method would enable health care professionals to monitor the potential for contagious illnesses to be spread among a building's population. Monitoring adverse health symptoms as reported by occupants via smartphone applications in specific areas of the building would also be possible.

These methods and sampling strategies are in their infancy, but the opportunity for accurate, real-time IAQ data using smartphones and other devices is very promising. As Steele and Clarke state, "It is also likely that feasibility and functionality of such systems will improve as component expenses decrease and technical challenges are further overcome."[2]

Green Buildings and IAQ

Many IAQ professionals are asked to provide technical assistance during and following the construction of new buildings. In particular, construction and engineering firms whose buildings conform to the U.S. Green Building Council's 2009 Leadership in Energy and Environmental Design (LEED) rating system for building design and construction (BD&C) have requested IAQ professionals to provide construction IAQ management plans (EQ Credit 3.1). IAQ professionals are also being asked to conduct air sampling prior to occupancy in compliance with EQ Credit 3.2, Option 2.[3]

For the EQ Credit 3.2 prior to occupancy, there are two options: a "flush-out" of the building, or IAQ testing. In many circumstances, the flush-out option has proved to be impractical since the flush-out must occur "while maintaining an internal temperature of at least 60°F (15°C) and relative humidity no higher than 60 percent."[3] The IAQ testing option requires that the testing be completed "after construction ends and prior to occupancy using testing protocols consistent with the EPA *Compendium of Methods for the Determination of Air Pollutants in Indoor Air* or the ISO method listed in the table" in EQ 3.2. The table also lists the contaminants to be tested and the maximum allowable concentrations (MACs) for each contaminant.

The IAQ air sampling option is worth one point in the 2009 version of LEED BD&C. In the newest version, BD&C LEED v4, the IAQ air sampling option is now worth two points, offering one more point than the flush-out option. In LEED v4, there has also been an addition to the proposed EQ Credit 3.2 Maximum Concentration Limits table regarding the California Department of Public Health Standard Method v1.1–2010, Allowable Concentrations, Table 4-1, which was published in 2010. Table 4-1 is a new list of 35 volatile organic compounds (VOCs) with non-cancer chronic reference exposure levels (CRELs). The MACs for these 35 new VOCs are in the microgram per cubic meter ($\mu g/m^3$) range. A footnote to Table 4-1 mentions that MACs are one-half the corresponding CREL adopted by the Cal/EPA Office of Environmental Health Hazard Assessment.[4]

This change will mean that sampling for VOCs to earn two points will become even more complicated under LEED v4. Construction companies and LEED-accredited professionals call on IAQ professionals to conduct this type of testing. (An exception for retail projects allows the air testing to be conducted within 14 days of occupancy. It is not clear exactly why this exception was granted or how the IAQ measurement will be affected by occupancy.)

New Phthalates Research

During the July 2012 Healthy Buildings conference in Brisbane, Australia, numerous papers were presented on phthalates research. An entire technical session was devoted to these papers, which focused on settled dust in homes containing various phthalate compounds, including those commonly found in plasticizers (substances added to plastics to increase flexibility, transparency and durability).

Phthalates show up in many products, including plastics, cosmetics and other personal-care products, adhesives, medications, industrial solvents, vinyl flooring, sealants, toys, and food containers and packaging.[5] Because no covalent bonds form between phthalates and plastics when they're mixed—as they often are—phthalates are more easily released into the environment. This process accelerates as plastics age and break down. Indoor air concentrations of phthalates are generally higher than outdoor concentrations because the majority of phthalate-containing products are used indoors. Higher air temperatures can contribute to higher phthalate concentrations in the air.[6]

There is concern that exposure to phthalates may cause hormonal changes, birth defects, wheezing, and breast cancer. However, only a few studies have focused specifically on these outcomes in the home related to phthalate exposure. The EU is phasing out certain phthalates from use in products, and this effort can be expected to affect the manufacturing and use of phthalates in North America. Since the majority of human exposure to phthalates takes place in the home, IAQ consultants will likely be asked to evaluate phthalate exposures in the future.

The Future of IAQ Consulting

These potential IAQ issues and the opportunities for technical assistance to solve these problems are the future of IAQ consulting. Many other opportunities for IAQ professionals exist in areas such as flame retardants; mold in buildings where sensitive operations, such as pharmaceutical manufacturing, are located; and *Legionella* in cooling towers. The future for IAQ consulting is therefore quite bright: as long as people live, work, and play in controlled environments, they will need solutions to IAQ problems.

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