Indoor Air Quality (IAQ) Standards

IAQ design – shift towards harm-based metrics

Historically, building standards have been founded on established air quality metrics mainly based on concentrations of contaminants. However, there is a potential change on the horizon, as articulated in the recent report from the ASHRAE Standing Standard Project Committee on Ventilation and Acceptable Indoor Air Quality in Residential Buildings (62.2). *Simon Jones (above), founder, Air Quality Matters,* analyses its implications.

Understanding the new addendum

The core development introduced by ASHRAE 62.2 is the potential addendum proposing a "harm-based indoor air quality procedure" as an alternative method of compliance. In layman's terms, rather than solely measuring and managing the concentration of indoor air pollutants, this addendum would incorporate the actual harm these pollutants may cause.

To the traditional engineer, this marks a shift in understanding and addressing indoor air quality. Where once the challenge was primarily measuring quantities (how much of a pollutant is present?), it now spans into understanding and mitigating qualitative impacts (how harmful is the pollutant to the building occupants?).

Harm-based v. level-based metrics

To truly grasp the implications of this new proposal, it is essential to understand the difference between harm-based and traditional level-based metrics of IAQ.

Airborne contaminants have various origins – from internal sources like building materials and furnishings to external sources brought in by ventilation. Exposure to these contaminants depends on their concentration and the time a person spends in that environment. Notably, every individual reacts differently to these exposures based on their metabolic rate, physiology, age and sex.

Historically, indoor air quality standards have also revolved around occupant perception, using human senses as a primary measurement tool. But human senses have their limitation. This is evident where harmful gases like carbon monoxide – which is odourless – go undetected.

Exposure limit values (ELVs) serve as benchmarks in the professional environment, setting maximum acceptable concentrations for contaminants. But, there are discrepancies between different organisations. The World Health Organisation and the US Environmental Protection Agency, for instance, have varied ELVs for the same contaminants.

Disability-Adjusted-Life-Years (DALY), which measures the potential years of healthy life lost and premature death due to exposure, considers the direct health effects and broader impacts on quality of life. This metric offers a more holistic view of the harm caused by indoor air pollutants.

The Lawrence Berkeley National Laboratory used DALY to estimate the chronic harm from exposure to airborne contaminants in dwellings, around a decade ago[1].

The University of Nottingham and International Energy Agency Annex 86 has revisited Logue's analysis to consider energy efficient indoor air quality management in residential buildings. They have updated the epidemiological and toxicological models and created a database of supporting information compiled from new research carried out over the past decade to rank the chronic harm caused by contaminants[2].

Taking contaminant concentrations from over 800 data sets and combining them with harm intensities, it identified those contaminants that cause the greatest harm. "This approach is the first to consider harm as a basis for regulating contaminants. This is a much more efficient approach because it will have the greatest effect on the greatest number of people for the least cost," says Dr Benjamin Jones, Associate Professor, University of Nottingham.

The top six are: PM2.5 (~66% of all harm); the course fraction of PM10 (~13%); formaldehyde (~9%); nitrogen dioxide (~8%); radon (~2%) and ozone (~1%).

Future of IAQ regulation

Drawing on the Nottingham research, the ASHRAE 62.2 Committee has identified three core contaminants of concern – PM2.5, formaldehyde and nitrogen dioxide. Together, these pollutants account for over 83% of the total harm caused by indoor pollutants in residential settings.

Yet, how will these insights influence actual engineering practices? The complexities of the DALY metric mean they won't become an everyday tool. Instead, harm intensities from this research can be used to establish harm budgets, allowing engineers to ensure that the cumulative harm from multiple contaminants remains below a threshold.

The proposed addendum to ASHRAE 62.2 represents a significant shift in the engineering world's approach to indoor air quality. The conversation is no longer just about quantities … now it is also about understanding the qualitative harm of these contaminants.

For those engineers committed to creating safe, healthy indoor environments, this new direction promises a future where building designs are even more closely aligned with human health and wellbeing.

The focus of this work to date has been on residential settings, but it is understood that similar work is considering workplace research.

Interesting conclusions

This work points to some interesting conclusions. Most of the harm in a residential setting is caused by particulate matter. The sources of this and NO2 can often be combustion, principally from cooking. Therefore much tighter control on providing adequate exhaust of cooking pollution should be the focus of future standards.

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While formaldehyde in the home is mostly a source-control issue, adequate background ventilation is an area we know needs far more attention, which could also be a significant area of focus.

Interestingly, harm from bio-aerosols – which includes mould – is just behind ozone, which might be a surprise for some considering the press it has received in the last year. Also, while this index is a population-level metric and harm intensities will change within a given sector, it should still be noted that you would have to reduce the harm of particulate matter by many orders of magnitude to equate the level of harm caused by exposure to mould. It does not consider harm to the building, which brings its own cost, of course.

All of these things – ventilation, filtration and managing air in buildings – are subjects engineers are well placed to handle. This work helps to draw a straight line from air quality to health and, by extension, may increase the value placed in this critical pillar of the built environment. ■

Reference

1. Logue, J.M., P.N. Price, M.H. Sherman, B.C. Singer. 2012. "A Method to Estimate the Chronic Health Impact of Air Pollutants in U.S. Residences." Environmental Health Perspectives 120(2):216 – 222.

2. IEA. Energy in Buildings and Communities Programme. Annex 86 – Energy Efficient Indoor Air Quality Management in Residential Buildings. www.annex86.iea-ebc.org