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WoS, Google Scholar et Lens

Han, J., Xu, D., Xu, D., Yang, X., Wang, Q., Chen, M.*, et al.*
Air Pollution Health Impact Monitoring and Health Risk Assessment Technology and Its Application—China, 2006–2019.
China CDC Weekly, Vol. **4** n°(26), (2022), pp. 577-581

Air pollution is a significant risk factor contributing to the burden of disease in China. Health risk assessment and management are important to reduce the impact of air pollution on public health. To help formulate standardized health risk assessment techniques, a series of studies were conducted from 2006 to 2019. Through systematic review, study of molecular mechanisms, epidemiological investigation, and health effect monitoring, the overall project established a monitoring and evaluation indicator system, a comprehensive information platform, software for automatic data cleaning, and standardized health risk assessment techniques. Technical specifications have been issued by the National Health Commission for promoting health risk assessments across China. This paper introduces the project, the research approach, its main research accomplishments, innovations, and public health significance, and describes directions for further research.

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Jones, B. W.
Aircraft Air Quality and Bleed Air Contamination Detection.
Kansas State University. United States. Department of Transportation. Federal Aviation Administration report 2022

The purpose of this project was to provide a data-driven process to identify sensing technology with good potential for detecting bleed air contamination from engine oil, hydraulic fluid, or deicing fluid. Reports from major aircraft cabin air studies were

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Walker, I., Less, B., Lorenzetti, D., Sohn, M.
Analysis of Zoned Residential Ventilation Systems.
Lawrence Berkeley National Laboratory report 2022

Trends in home heating and cooling in the US are resulting in less mixing of air within dwellings, either due to not using central forced air systems, or to reduced loads and runtimes in high performance homes. This study examined the use of zoned ventilation systems using a coupled CONTAM/EnergyPlus model of new California dwellings, including a 1-story single-family dwelling and a single apartment unit. Zoned and unzoned ventilation systems were simulated for exhaust, supply and balanced fan types. Smart controls were designed to reduce ventilation energy use and provide equivalent occupant pollutant exposures, using metrics that allow the efficacy of ventilation to be calculated on a zonal basis. The key metric was the personal exposures of the dwelling occupants to a number of contaminants of concern, including moisture, formaldehyde, CO2, particles and a generic contaminant., Emission rates were based on previous field studies and research literature, and they include a mixture of episodic and background emissions that were scheduled to align with zone occupancy patterns and activities (e.g., cooking, bathing, sleeping). These personal exposures were compared for smart controlled and baseline reference cases to ensure equivalence, as well as between zoned and unzoned fan types. Results showed that while zonal ventilation has the capability to save energy beyond that offered by single-zone approaches, care is required in the design and evaluation of zonal controls because all control types led to increased personal exposures for at least one of the contaminants. Substantial differences were identified between fan types, in terms of their ability to deliver outside airflow to occupied zones, the resulting personal pollutant exposures, and in energy performance.

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Liu, S., Jian, Y., Liu, J., Guo, R., Zhu, W.
Associating occupants ? interaction with windows with air change rate --One case study.
Building and Environment, Vol. **222**, (2022)

Air change rate (ACR) significantly influences the indoor thermal environment and indoor air quality. Moreover, as a matter of fact, ACR varies with time during natural ventilation. However, to date only a few studies have accounted for the dynamic ACR for the actual in-use buildings. To address this issue, a field measurement of outdoor/indoor environments and the window state was conducted in a dormitory in Beijing in spring, summer, and autumn. Transient Mass Balance Equation (TMBE) method associated with the extended Kalman filter (Hereinafter referred to as Kalman filter method) was adopted to obtain the dynamic results of the ACR. Then the correlations of outdoor/indoor environments with the ACR and the probability of window opening were investigated. The results confirm the validity of Kalman filter method for tracking the dynamic nature of natural ventilation in residential units, and further demonstrate that occupants' interaction with windows does not simply refer to opening/closing windows, but also refer to adjusting the extent of the window being open in response to occupants' ventilation needs. Therefore, in addition to the probability of window opening, ventilation needs, i.e., the dynamic ACR, as the underlying trigger for window opening behavior, should be used as an indispensable part of describing occupants' interaction with windows. This study provides a complete framework to describe occupants' interactions with windows by combining the dynamic ACR and the probability of window opening.

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Fu, P., Zhao, Z., Norback, D., Zhang, X., Yung, K. K. L.

Associations between indoor environment and lifestyles and sick building syndrome symptoms among adults in Taiyuan and Urumqi of China.

Indoor Air, Vol. **32** n°(7), (2022)

Abstract The complex and uncertain causes of sick building syndrome (SBS) have become one of the most challenging and hot issues worldwide. Studies on the correlation between indoor environment and SBS based on local characteristics are relatively limited in China. We studied typical SBS risk factors related to the indoor environment and lifestyle in two northern Chinese cities. The study population was drawn from parents of pre-school children in randomized daycare centers in Taiyuan, Shanxi, and Urumqi, Xinjiang, China (N = 6838). Data on SBS and indoor environment were obtained from cross-sectional questionnaires. Odds ratios (OR) were estimated by multilevel logistic regression and adjusted using gender, atopy, own smoking, home size, and dampness index. Results showed that location, homeownership, year of construction completion, changes in the indoor environment (new furniture and decorations), and changes in indoor air (smoking, burning mosquito repellent and incense, cooking fuels including electricity, natural gas, coal, and wood) might contribute to different levels of SBS in Chinese adults, including eye, nasal, throat, dermal symptoms, and headache and tiredness. The results of the subgroup analysis suggest city and gender differences in susceptibility. Daily cleaning, window opening, and improved ventilation effectively improved SBS. People should improve their indoor environment and lifestyles based on sensitivity factors, gender, and geographic characteristics to reduce SBS risks.

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Halios, C. H., Landeg-Cox, C., Lowther, S. D., Middleton, A., Marczylo, T., Dimitroulopoulou, S.

Chemicals in European residences - Part I: A review of emissions, concen- trations and health effects of volatile organic compounds (VOCs).

Science of the Total Environment, Vol. **839**, (2022)

One of the more important classes of potentially toxic indoor air chemicals are the Volatile Organic Compounds (VOCs). However, due to a limited understanding of the relationships between indoor concentrations of individual VOCs and health outcomes, there are currently no universal health-based guideline values for VOCs within Europe including the UK. In this study, a systematic search was conducted designed to capture evidence on concentrations, emissions from indoor sources, and health effects for VOCs measured in European residences.We identified 65 individual VOCs, and the most commonly measured were aromatic hydrocarbons (14 chemicals), alkane hydrocarbons (9), aldehydes (8), aliphatic hydrocarbons (5), terpenes (6), chlorinated hydrocarbons (4), glycol and glycol ethers (3) and esters (2). The pathway of interest was inhalation and 8 individual aromatic hydrocarbons, 7 alkanes and 6 aldehydes were associated with respiratory health effects. Members of the chlorinated hydrocarbon family were associated with cardiovascular neurological and carcinogenic health effects and some were irritants as were esters and terpenes. Eight individual aromatic hydrocarbons, 7 alkanes and 6 aldehydes identified in European residences were associated with respiratory health effects. Of the 65 individual VOCs, 52 were from sources associated with building and construction materials (e.g.

brick, wood products, adhesives and materials for flooring installation etc.), 41 were linked with consumer products (passive, electric and combustible air fresheners, hair sprays, deodorants) and 9 VOCs were associated with space heating, which may reflect the relatively small number of studies discussing emissions from this category of sources.A clear decrease in concentrations of formaldehyde was observed over the last few years, whilst acetone was found to be one of the most abundant but underreported species. A new approach based on the operational indoor air quality surveillance will both reveal trends in known VOCs and identify new compounds.

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Ridzuan, N., Ujang, U., Azri, S., Yusoff, I. M.
Computational Fluid Dynamics of Wind Flow and Air Pollution Modelling: A Review on 3D Building Model Standards.
11TH IGRSM (International Conference and Exhibition on Geospatial & RemoteSensing) 2022. 8 - 9 March 2022 KUALA LUMPUR, MALAYSIA

Computational Fluid Dynamics (CFD) simulations are used to monitor air pollution events supported by real-world conditions digitally. Besides, wind flow that has a close relationship with air pollutants dispersion also can be visualized by using CFD simulation. The presence of a building, especially in terms of the building's geometry, impacts the air pollution dispersion and wind flow that occur around a building or in a specific research area. As there is an involvement of building models in the simulation, some of the standards for the building modelling: Computer-Aided Design (CAD), City Geographic Markup Language (CityGML), and Building Information Modelling (BIM), are being utilized in this type of study. Many types of research have been conducted to study the pollutants and wind flow using the CFD technique of these three standards. Hence, this review paper is used to presents several pieces of research on this related topic. Through this review paper, some of the drawbacks of the study were identified, such as the detailing of the building's geometry and the compatibility of each standard to be implemented in the CFD simulation.

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Fritz, H., Bastami, S., Lin, C., Nweye, K., To, T., Chen, L.*, et al.*
Design, fabrication, and calibration of the Building EnVironment and Occupancy (BEVO) Beacon: A rapidly-deployable and affordable indoor environmental quality monitor.
Building and Environment, Vol. **222**, (2022)

Indoor Air Quality (IAQ) monitoring is essential to assess occupant exposure to the wide range of pollutants present in indoor environments. Accurate research-grade monitors are often used to monitor IAQ but the expense and logistics associated with these devices often limits the temporal and spatial scale of monitoring efforts. More affordable consumer-grade sensors - frequently referred to as low-cost sensors - can provide insight into IAQ conditions across greater scales but their accuracy and calibration requirements need further evaluation. In this paper, we present the Building EnVironment and Occupancy (BEVO) Beacon. The BEVO Beacon is entirely open-source, including the software, hardware, and design schematics which are all provided on GitHub. We created 20 of these standalone, stationary devices which measure up to 24 parameters at a one-minute resolution of which we focus on carbon dioxide, carbon monoxide, total volatile organic compounds, temperature, and size-resolved particulate matter. We investigated the efficacy of two different calibration approaches - device-specific and environment-averaged - for these sensors as well as also provide an extensive discussion considerations for each of the sensors. Calibrated sensors performed well when compared to reference monitors or calibrated gas standards. The CO sensors yielded the best agreement (r(2)=0.98-0.99), followed by temperature (r(2)=0.89-0.99), CO2 (r(2)=0.62-0.99), and PM2.5 (r(2)=-0.13-0.91). In all cases, the device-specific calibration approach yielded the most accurate results. We evaluated our devices through a successful 11-week field study where we monitored the IAQ in participants' bedrooms. The work we present on consumer-grade sensors adds to the existing literature by considering sensor-specific calibration techniques and analysis. The BEVO Beacon adds to the successful line of similarly developed devices by providing an open-source framework that researchers can readily adapt and modify to their own applications.

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Xiao, L., Du, Z.
Effects of Evaporative Cooling Air Conditioning on Classroom Pollutants and Thermal Environment.
Environmental Health Insights, Vol. **16**, (2022)

Indoor particles and carbon dioxide concentration are major indices to evaluate indoor air quality. Based on the two-dimensional filler sieving model of the direct evaporative cooling segment, the porous media model was used for the simulation of the water filler section, the filtering efficiency of particle was simulated by adjusting the water drenching density and airflow velocity in different operating conditions. The three-dimensional classroom model used to change the exhaust outlet position and control the use of air conditioners simulated the indoor thermal environment and the changes in pollutant concentration. The Euler method and Lagrangian method were used to analyze the indoor flow field and particle sieving in the direct evaporation section, respectively. Conclusions show that in the application of evaporative cooling and stratum ventilation air conditioning system in classroom, the position of the exhaust port affects the concentration of carbon dioxide in the student's breathing area. The water filler section can effectively reduce the concentration of particle and carbon dioxide supplied indoors. The filtration efficiency of particle in outdoor air passing through the direct evaporative cooling section based on diffusion, inertial collision, and interception is affected by the combined effect of particle size, onward wind speed, and water spray density. The filtration efficiency of particle increases as the density of the spray water increases. With the increase of head-on wind speed, the filtration efficiency of coarse particulate matter is higher than that of fine particulate matter. The research results help policy makers decide whether to install evaporative cooling air conditioning in schools and determine which exhaust outlet positions are most effective in improving indoor air quality.

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Liu, W., Shi, L., Yin, R., Sun, P., Ren, J., Wang, Y.
Efficient Photothermal Elimination of Formaldehyde under Visible Light at Room Temperature by a MnOx-Modified Multi-Porous Carbon Sphere.
Materials, Vol. **15** n°(13), (2022)

Volatile organic compounds (VOCs) exert a serious impact on the environment and human health. The development of new technologies for the elimination of VOCs, especially those from non-industrial emission sources, such as indoor air pollution and other low-concentration VOCs exhaust gases, is essential for improving environmental quality and human health. In this study, a monolithic photothermocatalyst was prepared by stabilizing manganese oxide on multi-porous carbon spheres to facilitate the elimination of formaldehyde (HCHO). This catalyst exhibited excellent photothermal synergistic performance. Therefore, by harvesting only visible light, the catalyst could spontaneously heat up its surface to achieve a thermal catalytic oxidation state suitable for eliminating HCHO. We found that the surface temperature of the catalyst could reach to up 93.8 degrees C under visible light, achieving an 87.5% HCHO removal efficiency when the initial concentration of HCHO was 160 ppm. The microporous structure on the surface of the carbon spheres not only increased the specific surface area and loading capacity of manganese oxide but also increased their photothermal efficiency, allowing them to reach a temperature high enough for MnOx to overcome the activation energy required for HCHO oxidation. The relevant catalyst characteristics were analyzed using XRD, measurement of BET surface area, scanning electron microscopy, HR-TEM, XPS, and DRS. Results obtained from a cyclic performance test indicated high stability and potential application of the MnOx-modified multi-porous carbon sphere.

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Atamaleki, A., Zarandi, S. M., Massoudinejad, M., Hesam, G., Naimi, N., Esrafili, A.*, et al.*
Emission of aldehydes from different cooking processes: a review study.
Air Quality Atmosphere and Health, Vol. **15** n°(7), (2022), pp. 1183-1204

As one of the primary contributing sources of indoor air pollution, cooking oil fumes are generated from a series of thermodynamic reactions between food ingredients. Nowadays, various compounds, especially aldehydes in fumes with adverse health effects, are detected. In the current study, the sampling and experimental methods, emission factors, and health effects related to emitted aldehydes from various cooking styles such as frying, grilling, barbequing, roasting, steaming, and boiling were reviewed. Generally, oxidation of food fatty contents is the primary source of aldehyde generation, while the frying process had the most influence due to the high unsaturated fatty acid contents related to edible oil consumption. However, other cooking techniques with high temperatures (as accelerating parameters) such as roasting and microwave can also result in more aldehydes release. Furthermore, cooking with high fatty and water content are also able to generate more aldehydes. Finally, health risk assessment results related to investigated studies at three phases of lab-scale, home, and commercial kitchens showed an exceeded limit for both the carcinogenic and non-carcinogenic risk of aldehydes attributed to inadequate ventilation.

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Ninya, N., Vallecillos, L., Marce, R. M., Borrull, F.

Evaluation of air quality in indoor and outdoor environments: Impact of anti-COVID-19 measures.

The Science of the total environment, Vol. **836**, (2022)

This study monitors the presence of 88 volatile organic compounds (VOCs) and semi-volatile organic compounds (semi-VOCs) at the gas phase of seven indoor settings in a school in the city of Tarragona, Spain, and five outdoor locations around the city. The VOCs and semi-VOCs monitored were solvents (Solvents), aldehydes (Aldehydes), emerging organic compounds (EOCs), and other VOCs and semi-VOCs (Others). Passive sampling campaigns were performed using Carbopack X tubes followed by thermal desorption coupled to gas chromatography with mass spectrometry (TD-GC-MS). Overall, 70 of the target compounds included in the method were determined in the indoor air samples analysed, and 42 VOCs and semi-VOCs in the outdoor air samples. Our results showed that solvents were ubiquitous throughout the school at concentrations ranging from 272 mug m-3 to 423 mug m-3 and representing 68%-83% of total target compounds (Total). The values of Total in 2021 were three times as high as those observed at the same indoor settings in 2019, with solvents experiencing the greatest increase. A plausible explanation for these observations is the implementation of anti-COVID-19 measures in the indoor settings, such as the intensification of cleaning activities and the use of hydroalcoholic gels as personal hygiene. The Total values observed in the indoor settings evaluated were twenty times higher than those found outdoors. Solvents were the most representative compounds found indoors (74% of the Total). The concentrations of VOCs and semi-VOCs observed in the outdoors were strictly related to combustion processes from automobile traffic and industrial activities, with Others contributing 58%, Solvents 31%, and Aldehydes 11% of the Total. EOCs, on the other hand, were not detected in any outdoor sample.

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Justo Alonso, M., Madsen, H., Liu, P., Jørgensen, R. B., Jørgensen, T. B., Christiansen, E. J.*, et al.*

Evaluation of low-cost formaldehyde sensors calibration.

Building and Environment, Vol. **222**, (2022)

Low-cost sensors (LCS) are becoming ubiquitous in the market; however, calibration is needed before reliable use. An evaluation of the calibration of eight identical pre-calibrated formaldehyde LCS is presented here. The LCS and a reference instrument were exposed to a pollutant source(s) for the calibration measurements. After one year, some tests were repeated to check the drift and stability of calibration. This paper presents methodologies for calibration using data with significant autocorrelations. Autocorrelation in sensor measurements might be present when performing a frequent sampling. To obtain reliable results, sensor calibration methodologies must consider autocorrelation or serial correlation between subsequent measurements. Experimental design can be used to reduce the risk of highly autocorrelated measurement. Ordinary Least Squares Estimations should not be used when measurements are autocorrelated, as their central assumption is that the residuals are independent and identically distributed. Two alternative methods considering autocorrelation using a first-order Markov scaling are proposed: Maximum Likelihood and Restricted Maximum Likelihood Estimation (REML). REML has better compensations for the estimated parameters and the scaling parameters. Akaike information criterion was used to select the most significant parameters resulting in formaldehyde and temperature. The results were presented for only one of the eight sensors. According to EPA's recommendations, the tested formaldehyde LCSs were Tier III, supplementary monitoring. The LCS over-and under-estimated the values obtained by the reference sensor, but they presented very similar dynamic responses, indicating that LCS could be used to detect concentration changes after calibration.

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Xie, R., Xu, Y., Chen, G., Zhang, S.

Experimental study on the effect of the split-type air-conditioner on the transmission of smoking pollutants in a room.

Journal of the Air & Waste Management Association, (2022)

Environmental tobacco smoke (ETS) has become one of the most important sources of indoor air pollution. The study aimed to obtain the variation characteristics of typical air pollutant concentrations when people smoke in a closed room and explore the effect of the air-conditioner. A closed and air-conditioned room of 21 m(2) was taken as the research object. Fine particulate matter (PM2.5) and total volatile organic compound (TVOC) were measured while 10 cigarettes were burnt in smoldering or smoking mode, with the air-conditioner on or off. The contents of nicotine in condensate

samples were obtained by liquid chromatography. The impact of ETS on indoor air quality lasted for hours, causing typical pollutant concentrations to far exceed the Chinese standard. The PM2.5 produced by smoking was 11 times higher than by smoldering, but the TVOC produced by smoldering was more than by smoking. After one hour of the cigarette burning off, the PM2.5 concentration would be decreased by 96.1% with the air-conditioner on, in contrast to 67.9% with the air-conditioner off. Nicotine was detected in all samples of condensate from the air-conditioner. It is concluded that smoking cigarettes cannot be replaced by smoldering to evaluate the pollution of ETS. The air-conditioner has a positive effect on reducing the concentration of air pollutants produced by cigarette burning. More than 10% of the indoor nicotine may be taken away by condensate discharge, and its possible pollution should be paid attention to. Implications: This study provides new evidence of the effect of the split-type air-conditioner on ETS. The TVOC concentrations, which were less considered previously, were measured. PM2.5 concentration in human breathing zone can be reduced more quickly with the air-conditioner on. This study shows that there is a big difference in the concentrations of typical pollutants between smoking and smoldering. And it could be a guide for the formulation of relevant research methods. This study also demonstrates that the air conditioning condensate from the smoking room may contain nicotine. Attention should be paid to the recovery and utilization of such condensate.

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Earn, J.
Exploring the gap in the Occupational Safety And Health Administration (OSHA) laboratory standard: a literature review and recommendations to enhance histology laboratory safety practices.
Journal of Histotechnology, (2022), pp. 1-9

ABSTRACTThis article discusses current available resources with respect to regulatory agencies including the Occupational Safety and Health Administration (OSHA) for determining the requirements placed upon laboratories for handling of hazardous materials. The focus is specific to the histology laboratory and xylene use, and includes a literature review, admixed with historical reference points. Procedures and tasks in the histology laboratory are highlighted in relation to their connection to the quality of the work environment with an emphasis on air quality. Recommendations are provided for maintaining an appropriate work environment for the prevention of potential adverse health effects. The gap within the OSHA Laboratory Standard, i.e. a lack of explanatory language, leaves much open to interpretation regarding fume hood usage with volatile hazardous chemicals. As a result, both the level of safety training and the awareness of good laboratory practices (GLP) for handling volatile hazardous reagents such as xylene can become compromised.

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Wang, Q., An, D., Yuan, Z., Sun, R., Lu, W., Wang, L.
A field investigation into the characteristics and formation mechanisms of particles during the operation of laser printers and photocopiers.
Journal of Environmental Sciences, Vol. **26**, (2023), pp. 697-707

Indoor particle release from toner printing equipment (TPE) is a major health concern and has received wide attention. In this study, nine printing centers were randomly selected and three working phases were simulated, namely, non-working, normal printing/copying, and heavy printing/copying. The dynamics of the ozone (O-3), volatile organic compound (VOC), and particle emissions from TPE were determined by portable detectors. Results showed that particles, VOCs, and O-3 were indeed discharged, and particles and VOCs concentrations remained at high levels. Among them, 44% of the rooms represented high-level particle releases. Sub micrometer-sized particles, especially nanoparticles, were positively correlated with VOCs, but were inversely proportional to the O-3 concentration. Four elements, Ca, Al, Mg and Ni, were usually present in nanoparticles because of the discharge of paper. Si, Al, K, Ni and Pb were found in the submicrometer-sized particles and were consistent with the toner composition. The potential particle precursors were identified, which suggested that styrene was the most likely secondary organic aerosol (SOA) precursor. Overall, the use of the toner formulation and the discharge of paper attribute to the TPE-emitted particles, in which styrene is a specific monitoring indicator for the formation of SOA. (C) 2022 The Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. Published by Elsevier B.V.

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Lavoie, F.
Health Canada's Indoor Air Program: Risk Assessment and Research to Support Standards Development.

In: ASHRAE Topical Conference Proceedings; Atlanta, (2022). American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.; 2022. pp. 1-7.

Health Canada, a science-based organization, is the Government of Canada's federal department responsible for maintaining and improving the health of Canadians. As Canadians spend on average 90% of their time indoors, indoor air quality is an important environmental determinant of health. Health Canada's Indoor Air program develops and promotes best practices to improve indoor air quality by conducting human health risk assessments of indoor air contaminants, research into indoor air quality and strategies to reduce exposure, and outreach and engagement initiatives to communicate risk to various audiences. The main output of risk assessment activities by the Indoor Air program are the Residential Indoor Air Quality Guidelines (RIAQGs), which consist of short-term and long-term health-based exposure limits. The RIAQGs provide the scientific basis for actions to reduce exposure and/or protect health, guide research to address data gaps, and inform the development of communication and outreach products and activities. These actions have included support for regulation and standard development, such as the CSA-O160-16 Formaldehyde emissions standard for composite wood products and the CSA 6.19-01 standard Residential carbon monoxide alarming devices with positive results. The future direction of Health Canada's Indoor Air program includes seeking more opportunities to engage in and provide evidence-based support for the development and/or update of standards and certifications that have the potential to directly impact indoor air quality in Canada.

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Xue, M., Liu, J., Zhao, L., Pei, J.
Identification of odour compounds emitted by wooden boards with the presence of indoor ozone.
Building and Environment, Vol. **221**, (2022)

Indoor volatile organic compounds (VOCs) produce odours that reduce perceived air quality. Furnitures and indoor decoration are the main sources of indoor VOCs. Considering the increase in outdoor and indoor ozone concentrations, ozone, as a strong oxidant, can have an impact on indoor odour. Herein, medium-density fibreboard (MDF) and flame retarded plywood (FRP) were selected as experimental materials, and gas chromatography-olfactory-mass spectrometry (GC-O-MS) was performed to identify the odour compounds emitted by materials with and without 100 ppb ozone. MDF1, MDF2 and FRP emitted 6, 8 and 14 different odour compounds, respectively. MDF2 emitted moderate grassy and sour odours. FRP emitted moderate grassy, fruity, rubber and pine incense odours. After 8 h of exposure to ozone at a concentration of 100 ppb, MDF1, MDF2 and FRP emitted different odour compounds, respectively. The characteristic odours of MDF were aggravated. Except for pine incense odour, the intensity of other characteristic odours of FRP was weakened. Through cluster heatmap analysis and principal component analysis, the characteristic odour compounds of MDF and FRP were further clarified. Introducing a SOI model, the results showed that ozone exposure increased the SOI of MDF1 and MDF2 from 3.34 to 4.22 and from 4.11 to 4.44, respectively, and that the odour intensity of FRP decreased from 3.78 to 3.41. It can be determined that ozone may have opposite effects on the odour emitted by different materials. The results clarify the target pollutants for odour control research on wooden board emissions.

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Gushit, J. S., Mohammed, S. U., Moda, H. M.
Indoor Air Quality Monitoring and Characterization of Airborne Workstations Pollutants within Detergent Production Plant.
Toxics, Vol. **10** n°(8), (2022)

The indoor air quality (IAQ) of five workstations within a detergent production unit was monitored. Particulate matter (PM) was measured using a gravitational settlement method, and later characterized. To ascertain the quality of indoor air within the workstations, which could directly or indirectly affect the health and performance of the workers, a physical inspection of the plant premises was undertaken. The mean value of the following air-quality parameters; particulate matter(PM2.5), particulate matter (PM10), formaldehyde (HCHO), volatile organic compounds (VOCs), carbon dioxide (CO2), temperature (T) and percent relative humidity (%RH) were obtained within the range of 24.5–48.5 µg/m3, 26.75–61.75 µg/m3, 0.0–0.012 mg/m3, 0.09–1.35 mg/m3, 1137–1265 ppm, 25.65–28.15 °C and 20.13–23.8%, respectively. Of the particulate matter components characterized, sodium oxide (Na2O)—25.30 mg/m3, aluminum oxide (Al2O3)—22.93 mg/m3, silicon dioxide (SiO2)—34.17 mg/m3, sulfur trioxide (SO3)—41.57 mg/m3, calcium oxide (CaO)—10.94 mg/m3 and iron III oxide (Fe2O3)—19.23 mg/m3, were of significance. These results, compared with international standards for industrial indoor air quality, suggest that indoor air contamination emanating from the

chemicals used in production workstations is traced to the design of the plant structures and the activities carried out within the workstations.

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Cardoso, V. E. M., Simoes, M. L., Ramos, N. M. M., Almeida, R. M. S. F., Almeida, M., Fernandes, J. N. D.
A labelling strategy to define airtightness performance ranges of naturally ventilated dwellings: An application in southern Europe.
Energy and Buildings, Vol. **269**, (2022)

Energy efficiency and indoor air quality are frequently-two conflicting objectives when establishing the air change rate (ACH) of a dwelling. In Europe, the northern countries have a clear focus on energy conservation, leading to an obvious awareness of the importance of airtightness, which translates into a high level of regulation and implementation. Meanwhile, the southern counterparts experience a more com-plex challenge by having predominantly passive ventilation strategies and milder climates, which often results in a more permissive approach. This work proposes an innovative labelling methodology to classify the performance of naturally ventilated dwellings. A representative sample of a southern European national built stock is used in a stochastic process to create a pool of 43,200 unique dwellings. The simulation period refers to a month of the typical heating season in the southern European mild conditions. The results test the labelling methodology. With feature selection, ACH limits, and a labelling strategy, dwellings classify according to their ability to provide adequate ACHs. The terrain was the best splitter of the dataset from the applied categorical variables. Regarding continuous variables, the airtightness was the one explaining most of the variability of the outputted ACHs, followed by the floor area. From the best performing dwellings labelled as compliant (Com), the average airtightness level was 5.3 h(-1), with 4.9 h(-1) and 5.8 h(-1) in rural and urban locations. (C) 2022 Elsevier B.V. All rights reserved.

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Zheng, H., Krishnan, V., Walker, S., Loomans, M., Zeiler, W.
Laboratory evaluation of low-cost air quality monitors and single sensors for monitoring typical indoor emission events in Dutch daycare centers.
Environment International, Vol. **166**, (2022)

Daycare centers (DCCs) are where infants and toddlers (0-4 years old) spend the most time besides their homes. Given their higher susceptibility to the effects of air pollutants, as compared to older children and adults, indoor air quality (IAQ) is regarded as an essential parameter to monitor in DCCs. Recent advances in IAQ monitoring technologies have enabled the deployment of low-cost air quality monitors (LCMs) and single sensors (LCSs) to continuously monitor various indoor environments, and their performance testing should also be performed in the intended indoor applications. To our knowledge, there is no study evaluating the application of LCMs/LCSs in DCCs scenarios yet. Therefore, this study is aimed to assess the response of five types of LCMs (previously not tested) and five LCSs to typical DCCs emission activities in detecting multiple IAQ parameters, i.e., particulate matter, carbon dioxide, total volatile organic compounds, temperature, and relative humidity. These LCMs/LCSs were compared to outcomes from research-grade instruments (RGIs). All the experiments were performed in a climate chamber, where three kinds of typical activities (background; arts-and-crafts; cleaning; [in a total of 32 events]) were simulated by recruited subjects at two typical indoor climatic conditions (cool and dry [20 +/- 1 degrees C & 40 +/- 10%], warm and humid [26 +/- 1 degrees C & 70 +/- 5%]). Results showed that tested LCMs had the ability to capture DCCs activities by simultaneously monitoring multiple IAQ parameters, and LCMs/LCSs revealed a strong correlation with RGIs in most events (R-2 values from 0.7 to 1), but, for some events, the magnitude of responses varied widely. Sensirion SCD41, an emerging CO2 sensor built on the photoacoustic sensing principle, had a more accurate performance than all tested NDIR-based CO2 sensors/monitors. In general, the study implies that the selection of LCMs/LCSs for a specific application of interest should be based on emission characteristics and space conditions.

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Ding, L., Wang, L., Nian, L., Tang, M., Yuan, R., Shi, A.*, et al.*
Non-targeted screening of volatile organic compounds in a museum in China Using GC-Orbitrap mass spectrometry.
The Science of the total environment, Vol. **835**, (2022)

Non-targeted analysis (NTA) was used in identifying volatile organic compounds (VOCs) in a museum in China with the gas chromatograph (GC)-Orbitrap-mass spectrometer (MS). Approximately 230 VOCs were detected, of which 117 were observed at 100% frequency across all sampling sites. Although some were common in indoor environments, most of the detected VOCs were rarely reported in previous studies on museum environments. Some of the detected VOCs were found to be associated with the materials used in furnishings and the chemicals applied in conservation treatment. Spearman's correlation analysis showed that several classes of VOCs were well correlated, suggesting their common sources. Compared with compounds in outdoor air, indoor VOCs had a lower level of unsaturation and more portions of chemically reduced compounds. Hierarchical cluster analysis (HCA) were performed. The results suggested that the sampling adsorbents chosen may have a large impact and that a single type of adsorbent may not be sufficient to cover a wide range of compounds in NTA studies. The MonoTrap adsorbent containing octadecylsilane (ODS) and activated carbon (AC) is suitable for aliphatic polar compounds that contain low levels of oxygen, whereas the MonoTrap ODS and silica gel are good at sampling aliphatic and aromatic hydrocarbons with limited polarity. Principle component analysis (PCA) showed that the indoor VOCs changed significantly at different times in the museum; this may have been caused by the removal of artifacts and refurbishment of the gallery between sampling events. A comparison with compounds identified by chamber emission tests showed that decorative materials may have been one of the main sources of indoor VOCs in the museum. The VOCs identified in the present study are likely to be present in other similar museums; therefore, further examination may be warranted of their potential impacts on cultural heritage artifacts, museum personnel, and visitors.

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Wang, H., Wang, J., Feng, Z., Yu, C. W., Cao, S.-J.
Optimization of ventilation performance of side air supply for large indoor spaces using deflectors and slot air outlets.
Indoor and Built Environment, (2022)

Due to the large height and span of indoor spaces, efficient indoor ventilation performance may be difficult to achieve using the side air supply for large halls, to control the indoor air pollutants or reduce the infection risk, such as the transmission of COVID-19 within the breathing zone of occupants. An efficient Ventilation Mode with Deflector and Slot air outlets (VMDS) was developed by this study. The use of a deflector with slot air outlets was introduced by utilizing jet collision and adhesion effect to accentuate the ventilation performance of the side air supply for the large space. The numerical simulation model used in this study was validated experimentally. The VMDS was compared with three other side air supply modes used in large spaces, and the results were evaluated comprehensively. The results show that VMDS is effective in reducing indoor air pollutant concentrations and transmission of infectious diseases in large spaces while satisfying the energy efficiency and thermal comfort requirements. Compared with the common side-supply and side-return ventilation modes, VMDS can reduce indoor air pollutant concentration by nearly 40%, reduce the transmission risk of infectious disease to less than 1% at a low air change rate and increase the ventilation efficiency from about 0.85 to about 1.2. In addition, VMDS can theoretically reduce ventilation energy consumption by about 85%.

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Vera, T., Villanueva, F., Wimmerová, L., Tolis, E. I.
An overview of methodologies for the determination of volatile organic compounds in indoor air.
Applied Spectroscopy Reviews, Vol., (2022), pp. 1-50

Volatile organic compounds are a broad and important class of pollutants affecting the indoor air quality. They are emitted from commercial products, building materials, furniture, occupant activities and even occupants, etc., and can participate in the indoor chemistry reacting with oxidants or being formed from secondary reactions. Some VOCs are classified as carcinogens and are associated with a variety of health effects. Characterizing and quantifying the VOCs in the indoor environments is of paramount importance in order to implement preventive measures to minimize the human exposure. A correct assessment of human exposure or characterization of emission sources and indoor activities requires appropriate and efficient methods for sampling and analysis. Therefore, this review focuses on the different methodologies for monitoring VOC that must be selected when a sampling plan is designed considering the objective of the measure. Selecting the most suitable procedures for assessing VOCs requires proper knowledge on the existing standards and off-line (including the selection of the sorbent media) and online instrumentation. Knowing the advantages and drawbacks of the different techniques available can help to plan future studies.

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Zhang, T., Zhao, Y., Wang, S., Wang, J.
A passive pivoted window for stabilizing the natural ventilation rate.
Energy and Buildings, Vol. **267**, (2022)

Inmost situations, natural ventilation of buildings is not well controlled. Consequently, either insufficient ventilation or over-ventilation is inevitable. However, the use of an automatic window requires sensors and driving motors, which entails a non-trivial initial investment and maintenance cost. This investigation proposed a passive, horizontally pivoted window with the sash swinging in the wind for adjustment of the window opening size. The center of gravity of the sash is located above the pivot, while the section of the sash below the pivot is larger than the upper section. Due to the opposing actions of the gravitational torque and the torque created by the blowing wind, the size of the window opening increases or decreases with the wind speed. The above passive pivoted window was constructed and then installed in a laboratory house. The flow rate was measured as a function of the pressure difference. In addition, EnergyPlus modeling was used to simulate an apartment equipped with the passive pivoted windows after validation of the model. The natural ventilation rate, the percentage of time with unacceptable indoor CO2 concentration, and the cooling and heating loads were examined. The performance of the pivoted windows was also compared with that of the traditional regular windows. It was found that the passive pivoted window provided a much more stable natural ventilation rate and better indoor air quality without additional energy consumption. The passive pivoted window has no sensor or motor and thus requires no energy input.

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Arya, S., Chauhan, S., Kumar, R.
Plastic bonded plywood using waste polypropylene container.
Materials Today: Proceedings, (2022)

Plastic waste management is one of the most critical issues of the present era due to non-biodegradability of the material along with the enormous quantity of plastic waste generated globally. Repurposing the plastic waste is one of the possible solutions for managing such material. The present study explores the possibilities of using single use plastic food containers as an adhesive for making wood veneer based composite material akin plywood. The concept also addresses the formaldehyde emission based concerns during the manufacturing of conventional plywood using traditionally used adhesive i.e. Urea Formaldehyde, Phenol Formaldehyde, Melamine Urea Formaldehyde etc. The rate of generation of plastic waste is estimated to be 400 Mt year -1. In the present study the study focuses on preparation of plywood using Melia dubia veneers and polypropylene polymer based food containers as the binding agent. The containers were cut open to transform into sheet form and were placed between veneers and the assembly was hot-pressed to get panels. The effect of pressing temperature and type of food container (transparent and opaque) on the properties of the panels. Physical properties such as density, water absorption, thickness swelling and volumetric swelling were evaluated and mechanical properties like modulus of rupture, modulus of elasticity, tensile strength and glue share strength were also evaluated. There was no significant change in physical properties with variation in temperature and type of polypropylene boxes, however with change in pressing temperature there was significant change in mechanical properties. The modulus of rupture of plywood bonded with opaque polypropylene boxes at 165 °C and 185 °C was observed to be 85 ± 6.92 MPa and 73 ± 6 MPa, respectively.

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Sun, Z., Guo, W., Chan, C.-K., Jin, L., Griffith, S. M., Yu, J. Z.*, et al.*
Polyurethane Foam Face Masks as a Dosimeter for Quantifying Personal Exposure to Airborne Volatile and Semi-Volatile Organic Compounds.
Chemical research in toxicology, (2022)

Airborne volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) are commonly quantitated by collecting the analytes on solid sorbent tubes or passive air samplers, followed by solvent extraction and instrumental analysis, or by grab bag/canister measurements. We report herein a user-friendly sampling method by breathing through polyurethane foam (PUF) face masks to collect airborne VOCs and SVOCs for chemical analysis. Specifically, dibasic esters, phthalate esters, polycyclic aromatic hydrocarbons, linalool, and nicotine trapped on PUF masks were quantitated by gas chromatography-mass spectrometry analysis as model VOCs and SVOCs. Results showed that the amount of these model VOCs and SVOCs trapped on PUF masks is proportional to the exposure duration. After cross-validation by parallel sampling using XAD-2 packed sorbent tubes, the method was used to quantitate VOCs and

SVOCs in a variety of indoor and outdoor environments with varying air concentrations of analytes, temperature, humidity, and wind speed. Because air pollution is considered a major cause of many human diseases and premature deaths and the developed PUF mask sampling method showed high trapping efficiencies for both VOCs and SVOCs, it is believed that the developed sampling method will find wide application in assessing air pollution-associated disease risks with possible extension to more classes of VOCs and SVOCs when coupled with suitable instrumental detection methods.

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Sun, X., Li, C., Yu, B., Wang, J., Wang, W.
Removal of gaseous volatile organic compounds via vacuum ultraviolet photodegradation: Review and prospect.
Journal of Environmental Sciences, Vol. **125**, (2023), pp. 427-442

Volatile organic compounds (VOCs) have attracted much attention for decades as they are the precursors of photochemical smog and are harmful to the environment and human health. Vacuum ultraviolet (VUV) photodegradation is a simple and effective method to decompose VOCs (ranging from tens to hundreds of ppmV) without additional oxidants or catalysts in the air at atmospheric pressure. In this paper, we review the research progress of VOCs removal via VUV photodegradation. The fundamentals are outlined and the key operation factors for VOCs degradation, such as humidity, oxygen content, VOCs initial concentration, light intensity, and flow rate, are discussed. VUV photodegradation of VOCs mixture is elucidated. The application of VUV photodegradation in combination with ozone assisted catalytic oxidation (OZCO) and photocatalytic oxidation (PCO) systems, and as the pre-treatment technique for biological purification are illustrated. Based on the summary, we propose the challenges of VUV photodegradation and perspectives for its future development. (c) 2022 The Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. Published by Elsevier B.V.

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Zhang, J., Chen, D.-R., Chen, S.-C.
A review of emission characteristics and control strategies for particles emitted from 3D fused deposition modeling (FDM) printing.
Building and Environment, Vol. **221**, (2022)

The 3D fused deposition modeling (FDM) printing has been extensively applied in various building environ-ments. However, particles are unintentionally emitted during the printing and potentially caused adverse health effects to users. To comprehend these emitted particles, this review paper summarized the background infor-mation, formation mechanisms, measurement methods, characterization and emission control methods based on over 100 literatures published from 2015 to 2022. Although discrepancies of the data amongst the literatures were seen, in general, ABS filaments emitted the highest particle concentration with the largest particle size while PLA generated least particles with the smallest size. The median emission rates in the print of ABS, PLA and other filaments (average of 20 other filaments) were 2.2 x 10(10), 6.0 x 10(8) and 3.9 x 10(9) particles/min, respectively. The first quartile percentile and median geometric mean diameter (GMD) were 28.0 and 35.0 nm for ABS, 23.8 and 29.2 nm for PLA and 24.9 and 31.8 nm for the average of other filaments. Filaments with metal additives emitted smaller particles than the non-additive ones. Extra attentions should be paid as the particles from 3D FDM printing are with high concentration and very small sizes, which have a high deposition rate in alveoli. Effective control methods include modifying chemical composition, avoiding printing filaments higher than the recommended temperature, choosing reasonable low infill density and height, applying local ventilation with an enclosure and filters (particles can be removed more than 90%) and adjusting environment humidity if possible.

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Rodenas Garcia, M., Spinazze, A., Branco, P. T. B. S., Borghi, F., Villena, G., Cattaneo, A.*, et al.*
Review of low-cost sensors for indoor air quality: Features and applications.
Applied Spectroscopy Reviews, (2022)

Humans spend the majority of their time indoors, where they are potentially exposed to hazardous pollutants. Within this context, over the past few years, there has been an upsurge of low-cost sensors (LCS) for the measurement of indoor air pollutants, motivated both by recent technological advances and by increased awareness of indoor air quality (IAQ) and its potential negative health impacts. Although not meeting the performance requirements for reference

regulatory-equivalent monitoring indoors, LCS can provide informative measurements, offering an opportunity for high-resolution monitoring, emission source identification, exposure mitigation and managing IAQ and energy efficiency, among others. This article discusses the strengths and limitations that LCS offer for applications in the field of IAQ monitoring; it provides an overview of existing sensor technologies and gives recommendations for different indoor applications, considering their performance in the complex indoor environment and discussing future trends.

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Al Samman, S.
Sensor Location Methodology for Improved IEQ Monitoring in Working Environments.
In: ASHRAE Topical Conference Proceedings; Atlanta, (2022). American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.; 2022. pp. 1-8.

In the current era, sensors in buildings have become an essential requirement for wide applications such as monitoring indoor air quality (IAQ), thermal and environmental conditions, controlling building heating, ventilation, and air conditioning systems (HVAC). To accurately control the IAQ for all areas in the indoor space, it is necessary to obtain considerable data from different locations in the space for more precision. The airflow in a room is not uniform, which raises the question of where the environmental sensor should be positioned with regard to optimum performance of IAQ and thermal comfort. This paper uses a case study of an open-plan office in Loughborough, UK, to assess the indoor climate conditions from real-time measurements from several sensors placed in different locations in the office and investigates the potency of using ventilation effectiveness (Ez), one of the IAQ relative indicators, as a preference to locate environmental sensors. The air parameters measured by the sensors are indoor temperature (ta), relative humidity (RH), carbon dioxide (CO2), total volatile organic compounds (tVOCs), formaldehyde (CH2O) and particulate matter (PM2.5 and PM10). Computational fluid dynamics (CFD) simulations were conducted to identify the areas in the office with low Ez evaluated using the age-of-air. Results showed that the measurement of RH and CO2 levels were marginally different between the sensors. A larger difference was found for temperature, assuming local heat sources significantly influenced the measured temperatures. Also, the calculated Ez from the measured data of each sensor was found to be different for each sensor location. The results from field measurements and CFD simulations can support decision making regarding the position of environmental sensors and the collection of indoor climate data in open-plan offices.

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Wei, T.-B., Dang, L.-R., Hu, J.-P., Jia, Y., Lin, Q., Shi, B.*, et al.*
A Simple Phenazine Derivative Fluorescence Sensor for Detecting Formaldehyde.
New Journal of Chemistry, (2022)

Formaldehyde (HCHO) is a common chemical raw material but toxic and harmful in nature. Excessive HCHO content has extremely significant effects on the atmospheric environmental and the human healthy. To this endeavor, herein, we report a 1H-[1,2,3]triazole[4,5-b]phenazine(PHTA) that are capable of sensing HCHO by rapid change of fluorescence color or intensity in gas and solution. PHTA was directly loaded on the silica gel plate to make a portable solid sensor HCHO kit, which achieves sensitive, and selective detection of gaseous and liquid HCHO. Whether as a solid or liquid sensor of HCHO, PHTA enables safer and more convenient use compared to other sensor.

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Zou, Z., Yang, X.
Skin volatile organic compound emissions from 14 healthy young adults under controlled conditions.
Building and Environment, Vol. **222**, (2022)

The human skin is an important source of volatile organic compounds (VOCs) in indoor environments. In this study, VOC emissions from whole-body skin of 14 healthy young adults were measured using a specially designed environmental chamber under controlled conditions. The number of VOC species in whole-body skin emissions ranged from 38 to 69 and the total emission rate of all VOCs detected in whole-body skin emissions ranged from 164 to 518 mu g/h. The similarities of VOC species among different subjects were more prominent, while the emission rate of the same VOC among different subjects varied significantly. In particular, eight VOCs (acetone, 6-methyl-5-hepten-2-one (6-MHO), geranylacetone, hexanal, heptanal, octanal, nonanal, and decanal) were emitted from the skin of all subjects, most likely originating due to the reaction of ozone with human skin. These VOCs accounted for a relatively large proportion of the

total emission rate, indicating that the reaction of skin with ozone was an important source for skin VOC emissions. In addition, siloxanes, aldehydes, ketones, and alcohols contributed remarkably to whole-body skin emission rates. Overall, this study showed information on the apportionments of VOC species and emission rates of whole-body skin emissions, which shed more light on the emission characteristics of human skin as a VOC source.

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Afshari, A., Mo, J., Tian, E., Seppänen, O.
Testing Portable Air Cleaning Units–Test Methods and Standards: A Critical Review.
REHVA Journal, Vol. **59** n°(3), (2022), 13 p.

The most effective ways to reduce exposure to indoor air pollutants are to eliminate individual sources of pol□lution or to reduce their emissions. Another approach is source control i.e. if the outdoor pollution level is low, ventilation reduces the concentration of indoor particles by means of dilution. In addition, research studies show that removal control i.e. air filtration can be an effective supplement to source control and ventilation. Using a portable air cleaner, also known as air purifiers or air sanitizers can help to improve indoor air quality. Portable room air cleaners can clean the air in poorly ventilated spaces such as aged classrooms and offices, prisons, homeless shelters, etc., when continuous and localised air cleaning is needed.

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Salthammer, T.
TVOC - Revisited.
Environment international, Vol. **167**, (2022)

BACKGROUND: TVOC (total volatile organic compounds) has been used as a sum parameter in indoor air sciences for over 40years. In the beginning, individual VOC concentrations determined by gas chromatography were simply added together. However, several methods for calculating TVOC have become established over time. METHODS: To understand the manifold definitions of TVOC, one must trace the history of indoor air sciences and analytical chemistry. Therefore, in this work, the original approaches of TVOC are searched and explained. A detailed description of the measurement methods is followed by a critical evaluation of the various TVOC values and their possible applications. The aim is to give the reader a deeper understanding of TVOC in order to use this parameter correctly and to be able to better assess published results. In addition, related sum values such as TSVOC and TVVOC are also addressed. RESULTS: A milestone was the analytical definition of VOCs and TVOC in 1997. A list of VOCs that should at least be considered when calculating TVOC was also provided. This list represented the status at that time, is no longer up-to-date and is being updated by a European working group as part of a harmonization process. However, there is still confusion about the exact definition and reasonable application of TVOC. The signals of other sum parameters, measured with photoacoustics, flame ionization, photoionization or electrochemical sensors, are also often given under the term TVOC. CONCLUSIONS: It was recognized early that TVOC is not a toxicologically based parameter and is therefore only suitable for a limited number of screening purposes. Consequently, TVOC cannot be used in connection with health-related and odor-related issues. Nevertheless, such references are repeatedly made, which has led to controversial scientific discussions and even court decisions in Germany about the correct and improper use of TVOC.

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Marc, M., Zabiegala, B.
Unconventional and user-friendly sampling techniques of semi-volatile organic compounds present in an indoor environment: An approach to human exposure assessment.
Trac-Trends in Analytical Chemistry, Vol. **154**, (2022)

The commonly applied solutions used to assess the potential risk of human exposure to semi-volatile organic compounds (SVOCs) are based on the investigation of biological samples collected in an invasive or non-invasive manner. For SVOCs, which are typically introduced to humans through the respiratory system, dermal adsorption, or digestive system, sampling solutions generally used in the indoor environments are classified as active and passive. From the user's perspective, the most convenient method to assess the potential risk is the use of an analytical tool that combines the benefits of passive and non-invasive sampling techniquesduse of an unconventional personal sampler such as a silicone wristband, brooch, dog tag, cotton gauze, or viscose wiper. Despite the advantages of this method, the

aforementioned techniques require further analytical research owing to the differences in the results of human exposure assessment owing to the lack of standards and unified sampling protocols.

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Jiang, Z., Kobayashi, T., Yamanaka, T., Sandberg, M., Kobayashi, N., Choi, N.*, et al.*
Validity of Orifice equation and impact of building parameters on wind-induced natural ventilation rates with minute mean wind pressure difference.
Building and Environment, Vol. **219**, (2022)

Natural ventilation is gaining more popularity in recent decades as a sustainable strategy to reduce energy consumption and improve indoor air quality. Due to variable turbulent characteristics, there is a lack of a practical guide that helps engineers accurately predict and maximize wind-induced ventilation rates. The current work intends to investigate the factors that influence the ventilation rates by focusing on cases that have a minor wind pressure coefficient difference. This paper presents an experimental study of single- and double-sided windinduced ventilation mainly through two openings of a reduced scale building with three different building aspect ratios in a boundary-layer wind tunnel. A continuous dose method of tracer gas technique was used to evaluate the ventilation rate. Important factors that affect ventilation rates such as velocity in the vicinity of the wall where the opening is assumed to exist (expressed as "nearby velocity") and surface wind pressure were measured. Flow visualization was also performed to help to understand the ventilation mechanism caused by turbulence. The experimental results showed that building aspect ratios of 1:2 and 1:3 generally led to higher ventilation rates than that of 1:1. Linear correlation between aperture separation and ventilation rates was reconfirmed regardless of openings symmetry. We noticed that the Orifice equation works well when the wind pressure coefficient difference is higher than 0.1. There is a positive correlation between the fluctuation of wind pressure coefficient and ventilation rates. The nearby velocity of the sealed model was uncorrelated with ventilation rates in this experiment.

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