

Google Scholar, Lens et WoS

Velasquez, J.

[Adaptive Workspaces and Real-Time Environmental Control: Optimizing Indoor Comfort Through Smart Systems.](#)

Research Gate, (2026)

The modern workplace is undergoing a fundamental transformation, driven by the convergence of IoT sensors, edge computing, artificial intelligence, and human-centric design principles. Traditional heating, ventilation, and air conditioning (HVAC) and lighting systems operate on static schedules and zone-level averages, failing to accommodate individual thermal and visual preferences while wasting significant energy. This study presents an adaptive workspace framework that integrates real-time environmental sensing, occupant preference learning, and predictive control to optimize indoor comfort across multiple dimensions—thermal, visual, air quality, and acoustic—while minimizing energy consumption. The proposed architecture comprises three layers:(1) a distributed sensor network capturing ambient conditions (temperature, humidity, CO₂, light intensity, occupancy) and occupant feedback (wearable-derived metrics, explicit preferences via interface),(2) a machine learning engine employing reinforcement learning and Bayesian optimization to learn individual comfort profiles and predict optimal setpoints, and (3) a multi-objective control system that balances comfort maximization against energy cost minimization through model predictive control (MPC). Implementation and evaluation across three office environments (total 120 workstations, 240 occupants, 18 months of continuous data) demonstrates that the adaptive system achieves 95.2% occupant satisfaction (compared to 67.8% under static control), reduces HVAC energy consumption by 28.6%, lighting energy by 41.3%, and overall building energy use by 33.8%. The system successfully learns individual preferences within 48 hours per occupant and adapts to seasonal variations, occupancy patterns, and utility pricing signals. A randomized controlled trial with 60 participants reveals that personalized environmental control improves self-reported productivity by 19.7% and reduces perceived fatigue by 27.4% compared to fixed setpoint conditions. The study contributes:(1) a reference architecture for adaptive workspace environmental control,(2) a preference learning algorithm that requires minimal explicit occupant input,(3) a multi-objective MPC framework with tunable comfort-energy trade-offs,(4) open-source implementation and datasets, and (5) design guidelines for organizations implementing smart environmental control systems.

Kleeman, M. J., Cappa, C. D., Green, P. G., Zhou, Y., Astaneh, M., Kant, S., *et al.*

[Airborne hexavalent chromium nanoparticles detected around cleanup zones for the 2025 Los Angeles wildfires.](#)

Communications Earth & Environment, (2026)

The 2025 Eaton and Palisades fires in Los Angeles (LA) exemplify destructive wildfires that increasingly threaten cities across the globe. The dangers during the post-burn cleanup phase from major urban wildfires are still being discovered. Here we report that airborne chromium bearing nanoparticles (diameter<56 nm) were found in the LA wildfire debris cleanup zones, a unique finding implicating the fires as a source of nanoparticle metals. The airborne chromium was predominantly in the carcinogenic +6 oxidation state two months post-fire with average concentrations of 13.7 ± 6.2 ng m⁻³, below the NIOSH

workplace exposure limit of 200 ng m⁻³ but above the US EPA screening levels for indoor air (0.1 ng m⁻³ for cancer; 3 ng m⁻³ for non-cancer effects). Model calculations indicate that chromium containing nanoparticles traveled 10–15 km downwind from the cleanup zone. Caution and health surveillance is warranted for nearby residents given that nanoparticles can easily cross cell membranes and circulate throughout the body.

Nur Fatin Zahirah, Z., Faiz Asraf, S.

[**AIRVIS 3D: Real Time Indoor Air Quality Dashboard for and Gas Leak Detection.**](#)

Progress in Engineering Application and Technology, Vol. 7 n°(1), (2026), 357-365 p.

This project presents AIRVIS 3D: Real-Time Indoor Air Quality Dashboard for Gas Leak Detection, focusing on the design and implementation of an interactive dashboard for real-time monitoring of indoor air conditions. The system integrates IoT sensors with an ESP32-based M5Stack microcontroller to detect harmful gases such as carbon monoxide, methane, and volatile organic compounds (VOCs). Sensor data is transmitted wirelessly to Firebase, which serves as the cloud platform for data storage and synchronization. The core component of this system is a user-friendly dashboard that visualizes gas concentration in a 3D spatial layout, enabling users to understand gas distribution across different indoor zones and heights. The dashboard includes alert indicators, live charts, and responsive design for desktop and mobile use. It allows for real-time updates, early warnings, and improved decision-making in managing indoor air quality. This project highlights the importance of intuitive dashboard interfaces in enhancing environmental monitoring, user engagement, and safety response in residential, commercial, and industrial spaces.

Chen, T., Zhu, T., Zhang, X., Dong, C., Zhang, C., Xie, Z., *et al.*

[**Al-Doped ZnO Nanoflakes for Volatile Organic Compound Sensing.**](#)

ACS Applied Nano Materials, Vol. 9 n°(21), (2026), 9748-9759 p.

ZnO, a widely studied metal oxide semiconductor, often suffers from low sensitivity and poor selectivity when used as a gas-sensing material. Herein, we report the rational design of Al-doped ZnO (AZO) nanoflakes with a hierarchical nanostructure assembled from interconnected nanorods via a nonhydrolytic sol–gel (NHSG) route. This nanoscale architecture provides a high specific surface area and abundant mesopores, enabling efficient gas diffusion and an increase in active sites for surface reactions. Meanwhile, homogeneous Al incorporation at the atomic level modulates the electronic structure and promotes the formation of oxygen vacancies, thereby enhancing the surface reactivity and charge-transfer kinetics. The 3 at. % AZO nanoflake exhibited optimal acetone-sensing performance, achieving a high response (R_a/R_g) of 198 toward 500 ppm acetone at 340 °C, which is 3.1 times higher than that of pure ZnO. The optimal operating temperature was notably reduced from 400 °C (pure ZnO) to 340 °C. Moreover, the sensor demonstrated excellent selectivity toward acetone against interfering gases such as formaldehyde, methanol, and toluene, along with remarkable long-term stability over 30 days and a reproducible dynamic response–recovery behavior. This work provides a simple and effective strategy for developing high-performance AZO-based gas sensors for acetone detection, showcasing their potential for industrial safety monitoring and indoor air-quality control.

Boonbangkeng, D., Sriwongsa, T., Treesubsuntorn, C.

[**Algae-based air purifier: Tackling CO₂, PM_{2.5}, and TVOCs to improve indoor air quality.**](#)

Building and Environment, Vol. 301, (2026)

Indoor air pollution has become a significant health concern due to the increasing time people spend indoors and the rising emissions of air pollutants from human activities. This study aimed to develop a 70 L pilot algae-based air purification (AAP) system for indoor air treatment, using *Chlorella sorokiniana* RMT01 as a biological filter. The efficiency of the AAP system was evaluated in both a controlled 24 m³ room and a real-life scenario in a 60 m³ room with four occupants. In the controlled 24 m³ room, the AAP system demonstrated significant improvements in air quality compared to the room without the system. Based on 5 cycles of experimentation, the AAP reduced CO₂, PM_{2.5}, and TVOCs from the average initial concentrations of 2255.1 ppm, 471.2 µg/m³, and 3131.4 ppb, respectively, to 1929.1 ppm, 176.1 µg/m³, and 174.4 ppb within 20 h per cycle. In contrast, the room without the system showed lower reductions, with CO₂ levels decreasing to 2209.5 ppm, PM_{2.5} to 446.4 µg/m³, and TVOCs to 309.9 ppb. In the 60 m³ room, CO₂ levels rose rapidly due to human respiration, but the increase was slower when the AAP system was in operation. Once the individuals left the room, CO₂ levels decreased more quickly, and O₂ levels rose faster compared to the room without the AAP. These findings suggest that the future development and application of algae-based air improvement technology could offer an alternative method for improving indoor air quality.

Subramani, J., Mukhila, A., Nidhisaa, S., Nisha, K.

[Analysis and Performance Evaluation of a Compact Hybrid CO₂—VOC Gas Sensor.](#)

2026 1st International Electronics & Packaging Technologies Conference: Bridging Skills & Innovation for India’s Industry (EPT India)

This paper presents the structural and functional design of a simulation-based hybrid sensor developed for the simultaneous detection of carbon dioxide and volatile organic compounds. Non-dispersive infrared (NDIR) for CO₂ detection and a Metal-Oxide Semiconductor (MOS) configuration for VOC sensing are two different sensing mechanisms that are combined into a single framework in the suggested model. Compact geometry, effective optical alignment, and material selection are prioritised in the design to guarantee exact gas diffusion and thermal stability. To reduce cross-interference and preserve independent calibration routes between the optical and chemical modules, a layered sensor design is implemented. To improve the even distribution of target gases across both sensor devices and fine-tune chamber size, thermal and flow simulations are employed. Adaptable to embedded system platforms and integrated circuit packaging, the hybrid topology offers low power consumption and modular scalability. Sensitivity, structural simplicity, and manufacturability are all balanced in the overall design approach, which lays the groundwork for nextgeneration hybrid gas sensors.

Engineers, H. C. T., Engineers, R. K. T., Trc, J. B., Trc, G. L.

[Automated Guideline 36 Validation.](#)

ASHRAE 2026

Building automation systems frequently underperform due to inconsistent control implementation, gaps in commissioning, and project-specific reprogramming that “reinvents the wheel.” American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Guideline 36 (G36) offers standardized, high-performance sequences of operation that can improve comfort, indoor air quality, and energy efficiency. Major building automation system manufacturers have also begun to release G36 programming libraries. However, in the absence of an objective, vendor-agnostic test standard, users cannot reliably assess their conformance, completeness, or robustness. Early field experience has shown inconsistencies and incomplete implementations, illustrating the need for a rigorous and repeatable validation method. This project developed a draft method of test and demonstrated an automated, repeatable bench-scale validation approach to confirm that control programming conforms to G36 sequences of operation, thereby enabling scalable quality control, supporting codes and standards, and reducing deployment risk. The method uses a software testbed connected to a physical building automation system controller to apply scripted operating

conditions and compare the controller's outputs to expected results. The approach provides objective, vendor-neutral validation that can be performed by programming developers as well as independent testing organizations.

Austin, C., Hayden, O.

[Behavioral Analytics in Intelligent Buildings: A Data-Driven Approach to Improving Occupant Wellbeing.](#)

Research Gate, (2026)

Intelligent buildings equipped with Internet of Things (IoT) sensors—occupancy, temperature, humidity, air quality (CO₂, PM2.5), lighting, and acoustics—generate vast streams of high resolution behavioral and environmental data. However, current building management systems (BMS) primarily optimize for energy efficiency, often neglecting occupant wellbeing, comfort, and productivity. This paper presents a data driven behavioral analytics framework that leverages passive sensing and machine learning to model occupant behavioral patterns, predict wellbeing indicators, and deliver personalized, real time interventions. The framework comprises three core components: (1) a multi modal sensing layer that fuses environmental data with anonymous occupancy trajectories (via Bluetooth low energy or millimeter wave radar) and self reported wellbeing surveys; (2) a behavioral modeling engine using a variational autoencoder (VAE) for unsupervised activity recognition and a temporal graph neural network (TGNN) to capture spatial temporal dependencies of occupant movement and environmental adjustments; and (3) a wellbeing inference module that estimates perceived comfort (thermal, visual, acoustic), indoor environmental quality (IEQ) satisfaction, and stress indicators (via heart rate variability from smartwatch integration where available). The system then provides personalized recommendations—lighting dimming, temperature setpoint adjustments, air purification activation, or quiet zone scheduling—via a mobile app or building dashboard. The framework is evaluated over 12 months across three intelligent office buildings (total 500 occupants, 200 IoT sensors). Results show that the VAE achieves 91% accuracy in activity recognition (sitting, walking, meeting, focused work) using only passive sensors. The TGNN predicts occupant thermal preference with 84% accuracy and 30 minute ahead occupancy patterns with 88% accuracy. Personalized interventions reduce reported discomfort by 43% (based on 7 point Likert scale), improve self rated productivity by 27%, and decrease stress indicators (HRV-derived) by 18% compared to static BMS schedules. Occupants also report 32% higher satisfaction with the building environment. The framework operates with a median inference latency of 120 ms and total data throughput under 50 KB per occupant per day, preserving privacy. These results demonstrate that behavioral analytics can transform intelligent buildings from energy centric systems into occupant centric wellbeing platforms, with measurable improvements in comfort, productivity, and health.

Zhao, C., Qu, Z., Qu, C., Pei, Y., Zhao, W., Liu, S., *et al.*

[Beyond concentrations: A multi-metric assessment of odor and health risks for VOCs in 76 newly renovated rooms in Beijing.](#)

Atmospheric Environment, Vol. **381**, (2026)

Conventional indoor air quality assessments rely heavily on chemical concentrations, yet fail to capture perceived odor and health impacts. This study introduces a multi-metric framework integrating chemical analysis, odor activity values (OAV), and health risk assessment across 76 residential, hotel, and office spaces post-renovation in Beijing. While formaldehyde was ubiquitous (4–687.5 µg/m³, 100% detection), aldehydes—especially hexanal, nonanal, and decanal—dominated odor contributions due to their high detection rates (>50%) and remarkably low odor thresholds (OAV_{max} up to 197.64). Distinct VOC profiles emerged: residences exhibited diverse alkanes and terpenes, hotels featured abundant esters and glycol ethers, while offices showed elevated aromatic hydrocarbons. Critically, formaldehyde and 2-ethylhexanol drove 98% of the non-carcinogenic hazard, with formaldehyde posing widespread carcinogenic risk. By

constructing scenario-specific odor wheels, this work moves "beyond concentrations" to provide an integrated, sensory-relevant, and health-protective framework for indoor air quality management.

Aniyikaiye, T. E.

[A Bibliometric and critical review of IoT-based air quality monitoring: Trends, technological challenges, and implications for developing regions.](#)

Scientific African, Vol. **32**, (2026)

This study provides a bibliometric and interpretive review of research on Internet of Things-enabled air quality management (AQIoT) published between 2015 and mid-2024, drawing on records from Web of Science and Dimensions. Using performance analysis and science-mapping techniques, the study examines publication growth, geographic distribution, collaboration networks, conceptual framework and thematic evolution, while critically situating these trends within ongoing methodological and structural challenges. Findings indicate sustained expansion of AQIoT scholarship, largely driven by advances in low-cost sensing, wireless communication, and data analytics. However, the persistent prominence of calibration, sensor performance, and data accuracy in keyword and trend analyses reveals continuing concerns regarding measurement reliability, cross-sensitivity, and long-term stability of low-cost sensors. The review further identifies interoperability gaps and technological fragmentation arising from heterogeneous platforms, proprietary analytical pipelines, and inconsistent metadata and calibration practices, which collectively constrain scalability and cross-jurisdictional integration. Research output remains concentrated in high-income countries, with comparatively limited representation from Africa and other developing regions despite acute environmental and public health needs. By linking bibliometric patterns with technical and governance constraints, the study offers strategic insights for advancing standardisation, improving data quality, and promoting interoperable, context-appropriate surveillance systems capable of supporting evidence-based environmental management.

Omlang, J. N., Lopena, J.

[CFD Assessment of Age-of-Air Distribution and Air-Change Effectiveness in a Detention Facility.](#)

E3S Web Conf., Vol. **709**, (2026)

Overcrowded detention cells often suffer from inadequate ventilation, posing significant health risks to inmates due to the buildup of airborne contaminants. To improve indoor air quality and comfort in such confined environments, this study investigates the influence of different supply air configurations on the age-of-air (AoA) distribution and air-change effectiveness (ACE) in detention cells of a city jail in the Philippines. Computational Fluid Dynamics (CFD) simulations using the standard $k-\epsilon$ turbulence model with scalable wall functions were conducted to evaluate four ventilation setups varying in the number of ducting lines and air supply grilles. CFD serves as a powerful and non-intrusive tool for analyzing ventilation systems, particularly in environments where physical testing is impractical or unsafe. Results show that configurations with three ducting lines provide more uniform airflow distribution across bunk levels, while increasing the number of supply air grilles decreases the average AoA and enhances ACE. Among the four setups, the configuration with three ducting lines and ten supply air grilles per duct achieved the most balanced performance in terms of airflow comfort and ventilation efficiency. The findings highlight the potential of CFD-assisted design optimization in improving air quality management in detention facilities and other densely occupied confined spaces.

Robert, L., Guichard, R., Klingler, J.

[Characterization of indoor air quality in logistics warehouses in France: environmental measurements and worker exposure assessments.](#)

Annals of Work Exposures and Health, Vol. **70** n°(4), (2026), wxag035 p.

The objective of this study was to provide data on the concentrations of volatile organic compounds (VOCs), aldehydes, and total dust levels in logistics warehouses, in order to identify substances of concern for indoor air quality (IAQ) and worker exposure in these buildings. Seven warehouses were selected based on the diversity of stored products. Active sampling of VOCs, aldehydes and particles was carried out over the course of 1 d, at 3 to 5 locations within each building, as well as outdoors. Among the 7 warehouses investigated, tire logistics centers were found to have the poorest IAQ, as reflected by significantly higher concentrations of total VOCs compared with the other warehouses, ranging from 1,079 to 3,747 $\mu\text{g}/\text{m}^3$ toluene equivalent, compared with 166 to 470 $\mu\text{g}/\text{m}^3$ in the other sites. Based on the total VOC concentration, more in-depth investigations were conducted in the working environment involving the most degraded IAQ, namely 1 of the 2 tire warehouses. These additional analyses, including emission cell degassing of a tire sample, a detailed air characterization, and personal exposure measurements, revealed the presence of several CMR substances in these working environments, such as MIBK and aniline.

Boudia, O., Della Puppa, A., Nicolas, M., Devetter, F.-X., Thevenet, F., Clerc, F., *et al.*

[Composés organiques volatils \(COV\) et produits d'entretien dans les écoles de la métropole de Nancy : estimation des expositions et des risques pour les agents de ménage pendant leur activité professionnelle.](#)

Archives des Maladies Professionnelles et de l'Environnement, Vol. **87** n°(3), (2026)

La perception de la qualité de l'air intérieur a fortement évolué depuis la crise de la COVID-19. La mise en place de nouvelles pratiques de nettoyage qui en a découlé a modifié les conditions de travail des agents d'entretien des espaces publics et des entreprises, avec une exposition potentiellement accrue aux produits ménagers. L'objectif de cette étude est d'évaluer les expositions et les risques associés aux émissions de composés organiques volatils (COV) lors des activités de ménage réalisées par les agents d'entretien des écoles de la métropole du Grand Nancy. Les 2 produits d'entretien les plus fréquemment employés (un nettoyant désinfectant multi-usage et un gel WC) pendant la période de ménage 16h–20h ont été considérés. L'évaluation a porté sur 18 substances chimiques disposant de valeurs de références et identifiées parmi les substances émises lors de la mise en œuvre des produits à échelle réduite dans une chambre de 50 L. Certaines de ces substances sont classées CMR (ex. benzène, formaldéhyde), d'autres irritantes respiratoires (ex. hexanol, octanol, décanol...). Les données issues des cahiers des charges des écoles et recueillies lors d'entretiens avec les agents de ménage ont été combinées afin de caractériser des tâches types (durée, fréquence, volume des pièces, quantités de produits) et de construire un scénario d'exposition représentatif. Les doses journalières d'exposition (DJE) par inhalation et voie cutanée ont été estimées à partir des équations recommandées par l'US EPA, en utilisant les concentrations issues des essais d'émission. Le logiciel CONSEXPO a été utilisé en parallèle dans une approche comparative. Les expositions estimées s'échelonnent de 10^{-2} à 10^3 mg/kg/j, les valeurs les plus élevées étant observées pour le dodécane et le 1-octanol. Une contribution non négligeable de la voie cutanée est mise en évidence pour certaines substances. La comparaison avec CONSEXPO met en évidence des écarts importants : pour 4 molécules (1-octanol, eucalyptol, 1-décanol et 1-hexanol), les DJE sont sous-estimées d'un facteur 10 à 100, et pour le dodécane, d'un facteur 108. Ces résultats illustrent les limites de CONSEXPO pour l'évaluation des expositions professionnelles déjà soulignées dans la littérature. Enfin, l'évaluation substance par substance ne met pas en évidence de risque dans les conditions étudiées pour les molécules disposant de VTR. De plus, les concentrations estimées sont nettement inférieures à celles rapportées chez les travailleurs français du secteur du nettoyage pour les composés les plus toxiques (benzène, formaldéhyde, toluène, n-hexane). Une évaluation cumulée des risques cancérogènes d'une part, et d'irritation respiratoire d'autre part, complètera ce travail.

Tavakoli, A., Tavakoli, A.

[A comprehensive assessment of indoor air quality and thermal comfort in chain stores: a case study from Iran.](#)

Scientific Reports, (2026)

This study thoroughly examined indoor air quality in six chain stores in Isfahan, Iran and involved the measurement of air pollutants (PM_{2.5}, PM₁₀, NO₂, SO₂, CO₂, bacteria and fungi), alongside noise levels and thermal comfort over four seasons (2023–2024). To address the diversity of pollutants and enhance decision-making, an indoor air quality index (IAQI) was proposed, based on the importance coefficient and pollutant duration of presence. The results revealed that concentration of PMs in the autumn was relatively higher than in other seasons, with a strong correlation ($R^2 = 0.926$) observed between PM_{2.5} and PM₁₀. For other parameters, levels remained within acceptable limits; however, noise levels in all seasons and stores exceeded standards. Airborne bacteria (312-1,007 CFU/m³), dominated by *Rhodococcus* and *Micrococcus*, and airborne fungi (639-1,332 CFU/m³), mainly represented by *Aspergillus* and *Penicillium*, were detected. Overall, most stores exhibited intermediate biological contamination levels across all seasons. The proposed IAQI for all seasons and stores, with some allowance for variability, falls into class D, corresponding to an intermediate/acceptable indoor air quality level. In conclusion, the air quality in studied stores does not pose an immediate concern for customers and visitors, continuous monitoring and the implementation of ventilation equipment are recommended to ensure the well-being of store personnel.

Chen, J., Chen, T., Wang, X., Shi, Y., Han, F., He, Y., *et al.*

[Concentrations characteristics of common air pollutants and health risk assessment of practitioners in hair and beauty salons in Shanghai, 2016-2024.](#)

Cabi Databases, (2026)

As common public facilities essential to daily life, hair and beauty salons frequently contain various airborne toxic and hazardous pollutants potentially leading to adverse health effects for salon practitioners. Objective To characterize the indoor air pollution profiles of common contaminants in hair and beauty salons in Shanghai and to evaluate the associated health risks for practitioners, in order to provide a scientific basis for strengthening the public health management in Shanghai and protecting the health of practitioners. Methods The air quality monitoring data of hair and beauty salons in Shanghai from 2016 to 2024 were obtained from the "Health Hazard Factors Monitoring Program for Public Places" of the National Institute of Environmental Health, Chinese Center for Disease Control and Prevention. Monitoring indicators included particulate matter $\leq 10 \mu\text{m}$ in aerodynamic diameter (PM₁₀), particulate matter $\leq 2.5 \mu\text{m}$ in aerodynamic diameter (PM_{2.5}), formaldehyde, ammonia, benzene, toluene, and xylene. Indicator compliance rates were calculated across various years in accordance with GB 9666-1996 Hygienic standard for barber shop and beauty shop and GB 37488-2019 Hygiene indicators and limit for public places; specifically, PM_{2.5} was assessed against the limits stipulated in GB/T 18883-2022 Standards for indoor air quality. A questionnaire survey was conducted among salon practitioners to collect weekly working days and daily working hours. The non-carcinogenic risks associated with inhalation exposure to formaldehyde, ammonia, benzene, toluene, and xylene as well as the carcinogenic risks posed by formaldehyde and benzene were evaluated following WS/T 777-2021 Technical guide for environmental health risk assessment of chemical exposure and the U.S. Environmental Protection Agency inhalation risk model. Results The overall compliance rates of PM₁₀, formaldehyde, ammonia, benzene, and toluene in the air of hair and beauty salons in Shanghai from 2016 to 2024 were 92.13%, 96.59%, 96.15%, 94.93%, and 94.97%, respectively; the overall compliance rate of xylene was a little lower (85.92%), and the overall compliance rate of PM_{2.5} was 57.18%. The P50 concentrations of PM₁₀, PM_{2.5}, formaldehyde, ammonia, benzene, toluene, and xylene did not exceed the corresponding limits. The P50 of non-carcinogenic risk indicator (hazard quotient, HQ) for formaldehyde, ammonia, benzene, toluene, and xylene were < 1 . The probabilities of non-carcinogenic risk $HQ > 1$ for formaldehyde and xylene were 41.4% and 10.9%, respectively, which were higher than that of other pollutants. The P50 of carcinogenic risk (CR) for formaldehyde and benzene were between 1.0×10^{-6} and 1.0×10^{-4} , while the probabilities of $CR > 1.0 \times 10^{-4}$ were 16.9% and 14.0%, respectively. Conclusion The overall compliance rate of common pollutant concentrations in the air of hair and beauty

salons in Shanghai is high, and the hygienic condition meets the requirements of national standards. The non-carcinogenic health risks posed by formaldehyde and xylene to employees (with formaldehyde being more prominent), as well as the carcinogenic risks associated with formaldehyde and benzene, deserve heightened attention in future health supervision.

He, Y., Liu, H., Ying, W.

[Construction of lignin-based aerogel with superelasticity and high reusability for air filtration and water pollution treatment.](#)

Industrial Crops and Products, Vol. **247**, (2026)

Developing lignin-based aerogels with high elasticity and excellent reusability for oil-water separation and PM2.5 removal is highly desirable. However, as lignin is a rigid structural material, how to make it possess good mechanical compression-recovery performance to enhance its usability and durability is a major challenge. To address this issue, HEC was incorporated into the alkali lignin (AL) matrix as a binder component, BAC served as a skeleton-reinforcing component, and MTMS acted as an elastic and hydrophobic modifying component, a lignin-based composite aerogel was obtained after freeze-drying. Benefiting from the synergistic effects among the multiple components, the resulted aerogel exhibits good hydrophobicity (WCA =131.7°) and high elasticity (50% strain, 100compression cycles, 99.2% shape recovery rate). Benefiting from its composite layered structure, the fabricated aerogel filter (50 mm in diameter, 5 mm in thickness) achieves good removal efficiency for PM2.5 (98.7%, 52 Pa), while exhibiting absorption capacities of 28.1–50.1 g/g for various oils and organics. Furthermore, due to composite layered structure and the interlayer repulsive forces within the lignin aerogel, it demonstrates outstanding mechanical properties and high reusability in oil/water separation applications (10 cycles, with only a 13.9% reduction in maximum oil absorption). Given its exceptional performance, the system exhibits great value for multifunctional lignin-based aerogel.

B. K, N., K. D, T., M. M, M., D, V., D. R, V., K, M.

[Design and Automation of Wet ESP-based Particulate Removal in Paper Industry.](#)

2026 Fourth International Conference on Augmented Intelligence and Sustainable Systems (ICAISS)

Removing fly ash and dust particles by hand from wet flue gases in the papermaking process can lead to unpredictable emission control, major maintenance burden, and inefficient operations. This study met its goals by designing a Wet ESP-Based Particulate Removal System using an ESP32 microcontroller for real-time monitoring and automating the electrostatic precipitation (ESP) process. The process hygienically removes fine particulates generated from the moist flue gases using high-voltage electrodes, continuous spraying of water, and automatic control of solenoid valves and relays. The ESP32 allows real time monitoring of the boiler temperature, pressure, and gas flow while enabling the proper operation of the high voltage discharge system. The water film created on the electrodes combined with the automatic operation, minimized the reentrainment of collected particles and improved the overall collection efficiency regardless of the level of gas moisture or gas loading. The slurry collection and discharge system operated automatically through relay control, thereby minimizing human intervention while increasing operational safety. The dashboard, enabled for the IoT, provides real-time process parameter feedback and alerts on unusual operating conditions to realize optimization and reliability.

Smargiassi, A., Debia, M., Suarthana, E.

[Effets respiratoires de l'exposition journalière aux particules respirables, fines et ultrafines dans divers milieux de travail. RS-1235.](#)

IRSST 2026

Même sur de courtes périodes, l'exposition quotidienne aux particules respirables en milieu de travail peut nuire à la santé pulmonaire. Une étude menée par des chercheurs de l'Université de Montréal et du Centre universitaire de santé McGill met en lumière des effets mesurables sur l'inflammation pulmonaire et la fonction respiratoire chez de jeunes travailleurs exposés à des particules fines et ultrafines.

Les résultats montrent qu'une exposition accrue, même sur quelques heures, est associée à une augmentation de l'inflammation pulmonaire et à une diminution de la fonction respiratoire, et ce, au niveau d'exposition actuellement rencontrée en milieu de travail.

Ces effets soulignent l'importance de ne pas sous-estimer les effets sanitaires des particules respirables, en particulier celles présentant un fort potentiel oxydatif capable de déclencher l'inflammation, une altération de la fonction respiratoire ou d'autres effets négatifs sur la santé lorsqu'elles sont inhalées de façon répétée.

Othman, H., Azari, R.

[Enhancing spatial indoor air quality sensing using a hybrid low-cost fixed mobile IoT network.](#)

Energy and Buildings, Vol. **365**, (2026)

As awareness grows regarding the critical impact of indoor air quality (IAQ) on human health, productivity, and overall well-being, there is an increasing demand for cost-effective and reliable IAQ monitoring solutions. In this work, we build upon a previously developed and validated low-cost IAQ sensing prototype and deploy it within a hybrid Internet-of-Things (IoT) sensing framework for spatial IAQ evaluation in indoor environments. Following calibration against reference instrumentation, multiple sensing nodes were integrated into a distributed network consisting of fixed stationary devices and mobile sensing units to enhance spatial coverage and temporal continuity for effective IAQ data monitoring. The proposed methodology focuses on improving the granularity of IAQ measurements by combining continuous monitoring from fixed sensors with space-filling sampling using portable nodes. This hybrid deployment enables the system to capture spatial and temporal variations in IAQ across a monitored environment while maintaining a cost-effective sensing strategy. To reconstruct IAQ fields from sparse measurements, Gaussian Process (GP) and Random Forest (RF) models were evaluated under random, periodic, and spatial cross-validation scenarios. Results show that GP consistently provides more accurate and variance-consistent predictions, particularly for CO₂ and relative humidity under structured and sparse sensing conditions, while RF performs competitively in more homogeneous scenarios. An autoregressive extension is further explored to reconstruct full spatiotemporal IAQ fields from sequential measurements. Temperature and relative humidity are reconstructed with high fidelity, whereas CO₂ remains more challenging due to its localized and transient behavior. The findings demonstrate that hybrid low-cost sensing networks, when combined with spatiotemporal modeling, can provide reliable and spatially resolved IAQ assessment.

Agrawal, A. P., Kumar, R., Ali, S., Ahamad, N.

[Evaluating Environmental Impact in Sustainable Coating Applications.](#)

In: *Eco-Friendly and Sustainable Coatings for Wear-Prone Industrial Applications*. CRC Press; 2026. 59-76 p.

Sustainable coatings are critical in reducing the environmental impact of industrial and consumer products, offering a greener and eco-friendly alternative to traditional petroleum-based coatings that emit volatile organic compounds (VOCs) and contain hazardous substances like heavy metals and isocyanates. This chapter systematically evaluates the environmental impact of coatings through material selection, manufacturing processes, lifecycle analysis, and end-of-life considerations. It showcases innovations like bio-based polymers, waterborne systems, solvent-free formulations, and low-VOC technologies that suit global goals of sustainability while offering superior performances in corrosion protection, mechanical

durability, and functionality. Novel materials such as bio-fillers, nanomaterials, and smart additives introduce functionalities like self-healing, antimicrobial activity, and super hydrophobicity, expanding applications to areas of automotive, aerospace, marine, and building. The chapter also highlights methods like Life Cycle Assessment (LCA) and carbon footprint analysis to measure environmental performance and inform sustainable practice. Case studies demonstrate effective applications, promoting their use within circular economy applications and environmental conservation. There remain challenges like high-cost bio-based starting materials, issues of scaling up, and optimization of performance. By integrating achievements and opportunities for innovation, this chapter offers researchers, industry leaders, and policymakers useful insights to steer sustainable practice and reduce environmental impacts for coating applications.

Frischmon, C., Porter, J., Balagopalan, E., Senga, W., Johnston, J., Hannigan, M.

[Evaluating machine learning model performance in a two-step colocation process for TVOC and BTEX sensor calibration.](#)

Atmospheric Measurement Techniques, Vol. **19** n°(9), (2026), 2923-2939 p.

Calibration of low-cost air quality sensors (LCSs) for total volatile organic compound (TVOC) and benzene, toluene, ethylbenzene, and xylenes (BTEX) quantification remains challenging due to the sensors' cross-sensitivity to temperature and humidity and their tendency to drift over time. In this study, we aimed to improve TVOC and BTEX metal oxide (Figaro TGS 2600, 2602, 2611) sensor calibration using a two-step colocation strategy. A two-step colocation places one LCS (the secondary standard) with a reference monitor while others operate in the field, then briefly colocates the field sensors with the secondary standard to address inter-sensor variability and drift. This strategy made it possible to develop the calibration model under environmental conditions closely matching those of the field, which is essential for model transferability from colocation to field conditions. In addition to TVOC and BTEX, we applied the two-step colocation process to NO₂ electrochemical (Alphasense B-4) sensors to demonstrate the broader applicability of our approach beyond TVOC and BTEX quantification.

Next, we compared the performance of multiple machine learning models, including ridge, lasso, random forest, gradient boosting, extreme gradient boosting, support vector regression, and linear regression, to investigate the optimal model choice for calibration. We found that no single model performed best across all pollutants. For example, gradient boosting excelled at capturing peak TVOC concentrations, while linear regression performed best for BTEX. Conversely, linear regression was the worst-performing model for NO₂. Overall, the models showed satisfactory RMSE around 40–50 ppb for TVOC, 1.25–1.75 ppb for BTEX, and 4–6 ppb for NO₂. However, all models also overestimated baseline concentrations and underestimated peaks. The severity of this bias depended on the reference concentration distribution, with the most severe peak underestimation occurring in the more heavily skewed TVOC and BTEX data. The systematic bias at baseline and peak concentrations was not evident in the overall mean bias error, which was near zero for all pollutants. This result underscores the need to evaluate model performance across the entire concentration distribution. Finally, we found that calibration performance was sensitive to the choice of training and testing data split. Future research could seek to optimize the training and testing split to ensure robust model transferability to field data.

Levilly, R., Moellinger, D., Fonty, S., Galland, B.

[Exposition au dioxyde de carbone dans les micro-brasseries artisanales.](#)

Archives des Maladies Professionnelles et de l'Environnement, Vol. **87** n°(3), (2026)

Au-delà d'être un indicateur de la qualité de l'air intérieur, le CO₂ est présent à l'état gazeux dans de nombreux secteurs d'activités industrielles où une problématique d'exposition professionnelle par inhalation peut alors se présenter. Partant du constat d'un manque de connaissance sur l'exposition des opérateurs de brasseries artisanales au CO₂ généré et/ou utilisé lors de la production de bière, le service de

prévention et santé au travail (SPST) APST 68 a sollicité l'INRS afin d'investiguer conjointement cette problématique sur leur secteur d'activité. La France comptait fin 2023 environ 2500 brasseries pour un effectif d'environ 8500 personnes. Les objectifs de ce partenariat étaient de plusieurs ordres : – collecter des données quantitatives robustes concernant les niveaux d'exposition des opérateurs au CO₂ et les niveaux de pollution des locaux ; – identifier et suivre les principales phases de travail des brasseurs et repérer les opérations les plus exposantes ; – proposer des mesures de prévention pour les situations de travail le nécessitant, en mesurer l'impact et les promouvoir. La stratégie retenue a été de déployer dans 3 micro-brasseries, un réseau de capteurs CO₂ composé de 10 à 20 balises (en fonction de la typologie des locaux) pendant 7 jours consécutifs. L'enregistrement continu, toutes les minutes, des données sur cette période visait à identifier les niveaux de concentration en dioxyde de carbone dans les ateliers de production à la fois lors de la présence des brasseurs et hors activités journalières (nuit) pour illustrer les phénomènes d'accumulation du gaz. En appui de ces mesures, des brasseurs ont été équipés de capteurs CO₂ individuels sur plusieurs postes de travail conjointement à des études de poste. Plusieurs enseignements ont pu être réalisés à la suite de ces métrologies de terrain : – il existe une variabilité importante des concentrations en CO₂ au cours du temps et de l'activité de production ; – les niveaux de CO₂ en ambiance peuvent atteindre plusieurs milliers de ppmv dans les locaux de production et administratifs pendant et en dehors des périodes de travail ; – la variabilité spatiale des concentrations en CO₂ au sein des entreprises est avérée ; – des pics d'exposition individuelle supérieurs à 50 000 ppmv ou 5 %V ont été enregistrés pour certaines tâches spécifiques des brasseurs ; – les installations suivies étaient dépourvues de système de ventilation mécanique, d'où une accumulation du dioxyde de carbone au cours du temps ; – une confusion générale existe chez les brasseurs entre le phénomène d'asphyxie (déficit en oxygène, O₂) et la toxicité propre du CO₂ (VLEP-8h de 5000 ppmv).

Mohamed, S. Z., Saad, R., El Sayed, A. M., Khabiri, G., Shaban, M., Mohamed, H. S. H.

[Improved CO₂ sensing behavior of SnO₂ thin-film sensors through Li/Ni codoping.](#)

Journal of Materials Science: Materials in Electronics, Vol. **37** n°(13), (2026), 963 p.

Developing room-temperature CO₂ sensors with high sensitivity at elevated concentrations remains a significant challenge for SnO₂-based materials, which often require high operating temperatures or noble-metal activation. In this study, pure SnO₂ (P.Sn), Li-doped SnO₂ (Sn:Li), and Li–Ni codoped SnO₂ (Sn:Li,3Ni) thin films were fabricated on glass substrates via spin coating and systematically characterized to evaluate the structural, chemical, and nanomorphological effects of doping. Li incorporation produced a highly porous surface that facilitated rapid gas adsorption, whereas Li–Ni codoping-induced pronounced nanostructural modifications and increased surface roughness, yielding a larger number of active adsorption sites. As a result, the Sn:Li,3Ni sensor achieved a response of 111.57% at 9990 ppm CO₂ under ambient conditions (30 °C, 40% RH), which is substantially higher than typical responses reported for SnO₂-based CO₂ sensors operating at room temperature (generally below 80%) or at elevated temperatures (often below 10% at 100–2000 ppm). The sensor also exhibited response and recovery times of 96.65 s and 171.25 s, respectively, along with excellent stability over 15 cycles and 15 days of operation. Additionally, the Sn:Li sensor demonstrated a low detection limit of 0.152 ppm, indicating strong detectability at trace CO₂ levels. These results confirm that Li–Ni codoping significantly enhances room-temperature CO₂ sensing performance and provides a low-cost, scalable route for developing high-efficiency gas sensors for indoor air-quality monitoring, environmental surveillance, and industrial safety applications.

Liu, Y., Li, J., Zhao, R., Du, J.

[In₂O₃ nanoparticles and nanoaggregates for formaldehyde recognition and mechanism insight: Enabled by engineering multi-crystal facets.](#)

Talanta, Vol. **309**, (2026)

The toxic and carcinogenic formaldehyde necessitate developing high-performance sensing material for its monitoring. Herein, we provided feasible strategy to prepare and integrated multiple crystal planes of In₂O₃ to enhance sensing performance for formaldehyde recognition. As-prepared In₂O₃ nanoparticles and cubic nanoaggregates with hollow structures and controlled oxygen vacancy provides plentiful diffusion space and adsorption sites for gas molecules, and accelerates electron transport by coupling with different crystal boundaries. The findings of research show that as-optimized In₂O₃ exhibits high sensitivity, selectivity and fast response/recovery to less than 100 ppm formaldehyde at low temperature of 120 °C, and practical stability during 14-day record. Notably, the linear relationships of concentration-dependent response endow In₂O₃ quantitative monitoring formaldehyde and limit of detection reaches 312 ppb, and sensing performance of In₂O₃ are superior to that of reported materials significantly. The sensing mechanism have been expounded by in-situ Diffuse Reflectance Infrared Fourier Transform Spectroscopy, and the gas sensing involves formaldehyde adsorption and nucleophilic addition, intermediate oxidation, dehydrogenation and oxidation. DFT calculations further confirm that low adsorption energy and electron transition of crystal planes are conducive to HCHO sensing performance. The portable device of microelectron mechanical systems integrated with In₂O₃ can be employed to monitoring formaldehyde efficiently, which drives the deployment of oxides sensing materials for intelligent sensor in environmental monitoring and life science applications.

Che Baharum Bin Che Busu, C. M. N. B. C. B., Prof. Madya Ts. Dr. Azian, H.

[Indoor Air Quality Assessment in an Aging Educational Building: A Case Study of the ICRC Office, UTHM.](#)

Research Progress in Mechanical and Manufacturing Engineering, Vol. 7 n°(1), (2026), 335-350 p.

Indoor air quality (IAQ) plays an important role in maintaining occupant health, comfort, and productivity, particularly in office environments. Aging buildings are often associated with ventilation limitations and deteriorated systems that may contribute to indoor pollutant accumulation. This study presents an IAQ assessment conducted at the Industry Community and Relations Centre (ICRC) Office, Universiti Tun Hussein Onn Malaysia (UTHM), an educational building established in 1999. The assessment involved walkthrough inspection, physical measurements using sensor-based instruments, subjective evaluation through an occupant questionnaire survey, and comparison with the Industry Code of Practice on Indoor Air Quality (ICOP IAQ 2010) guidelines and previous IAQ data. The subjective assessment focused on occupants' perceptions of indoor comfort and the occurrence of IAQ-related symptoms during working hours. Key physical parameters evaluated include air temperature, relative humidity, and air movement, while chemical parameters include carbon dioxide, carbon monoxide, ozone, formaldehyde, particulate matter, and total volatile organic compounds. Most parameters were within acceptable limits; however, particulate matter (PM₁₀) exceeded the ICOP IAQ 2010 limit of 0.15 mg/m³, with concentrations of 0.328 mg/m³ on Day 1 and 0.220 mg/m³ on Day 2. Elevated PM₁₀ levels are likely influenced by infrequent housekeeping activities and carpeted flooring. Correlation analysis indicated an association between increased particulate matter levels and reported symptoms such as fatigue and headaches, suggesting potential Sick Building Syndrome (SBS) conditions. The findings highlight the importance of continuous IAQ monitoring and proper maintenance of ventilation systems in aging educational buildings.

Priya, N. P., Dharshni, L. J., Nandhini, P. N., Kaviya, K., Nandhitha, M.

[An Intelligent Multi-Sensor IoT System with Deep Learning for Automated Restroom Hygiene Evaluation and Predictive Maintenance.](#)

9th International Conference on Inventive Computation Technologies (ICICT). 15-17 April 2026. Kirtipur, Nepal

Maintaining hygienic and safe restroom environments in high-traffic public facilities is essential for public health, user comfort, and operational efficiency. This research presents the design and implementation of a

data-driven smart restroom monitoring system that integrates multi-sensor environmental sensing, safety detection, computer vision, and predictive analytics. The system employs an SCD30 NDIR sensor for accurate CO₂ monitoring with ± 29.638 ppm accuracy and a mean absolute error of 28.742 ppm, enabling reliable ventilation threshold detection with 95.284% accuracy. VOC and gas monitoring are achieved using BME680, CCS811, and MQ-135 sensors, providing 94.517% VOC detection accuracy and 92.384% ammonia sensitivity, with a sensor drift rate limited to 0.912% over 30 days. Wet-floor detection achieves 96.742% accuracy, while occupancy monitoring attains 97.518% counting accuracy. Vision-based analysis using YOLOv5 reaches 94.736% mean Average Precision for object detection, and MobileNetV2 achieves 94.583% classification accuracy. An LSTM-based predictive model produces a root mean square error of 4.286% and a prediction accuracy of 95.274%. A weighted danger index consolidates environmental and safety parameters into a normalized 0–100% risk score for real-time assessment and alert generation. The results demonstrate accurate monitoring, stable operation, and effective predictive capability for intelligent restroom management.

Rohmah, U. N., Nadzirah, F., Aswoyo, B., Budikarso, A., Anisah, I.

[IoT-Based Monitoring and Control of Smoke Concentration in Fish Smoking Warehouses Using Fuzzy Logic and ESP32.](#)

Journal of Communication Systems, Networks, and Security, Vol. 1 n°(1), (2026), 7-12 p.

Fish smoking is a common practice for preserving and flavoring fish; unfortunately, traditional methods of smoking can produce dangerous air pollutants, including carbon monoxide (CO) and nitrogen oxides (NO₂), which have severe implications for workers' health and environmental performance. In this context, we propose an Internet of Things (IoT)-based intelligent system for real-time monitoring and control of smoke levels in fish smoking warehouses. The MICS-6814 gas sensor, combined with the ESP32 microcontroller, measures CO and NO₂ levels, while a fuzzy-logic algorithm classifies air quality using the CO₂-N₂ Air Pollution Standard Index (ISPU) from the reference. The proposed approach automatically controls ventilation via a fan actuator, which is triggered when pollutant levels exceed specific thresholds. The results of the experiment show that at a distance of 40 cm, as soon as it falls, this system is determined to be an unhealthy air condition if it starts automatic ventilation. Still, at a distance of 1 m, air quality remains moderate and therefore requires no action. The system enabled real-time monitoring, classification, and control, while data visualization was handled via a web-based interface and an LCD. Power, investigations repeatedly reported that indoor air quality management in fish smoking places demonstrated its practicality in reducing health risks from smoke exposure

Benzaazoua, M., Fall, M., Ouellet, S.

[Isocyanates en carrosserie automobile : mieux mesurer pour mieux prévenir RS-1236.](#)

IRSST 2026

Les isocyanates sont des substances chimiques organiques présentes dans les vernis polyuréthanes utilisés en carrosserie automobile. Appréciables pour leurs propriétés qui confèrent résistance et qualité de finition aux revêtements, ces substances sont également reconnues pour leurs effets nocifs sur la santé respiratoire. Leur inhalation peut notamment provoquer de l'asthme professionnel et d'autres maladies respiratoires chroniques, ce qui en fait un enjeu majeur de santé et de sécurité du travail dans les ateliers de carrosserie. L'exposition aux isocyanates est une des principales causes reconnues d'asthme professionnel au Québec.

Dans ce contexte, une étude de l'IRSST s'est penchée sur la performance de différents dispositifs de prélèvement d'isocyanates dans l'air lors de l'application de vernis polyuréthane. Menée à la fois en laboratoire et en milieu de travail, la recherche visait à comparer plusieurs méthodes de mesure afin d'évaluer leur fiabilité et leur capacité à tenir compte de la complexité de ces substances, présentes simultanément sous forme de vapeurs et de particules.

Gule, K., Suryavanshi, A. A., Shetty, S. S., Vaishnav, S. N.

[A Machine Learning Based Approach for Air Quality Index \(AQI\) Prediction.](#)

2026 13th International Conference on Computing for Sustainable Global Development (INDIACom)

The main sources of air pollution are such pollutants as PM2.5, PM10, NO2, and CO, whereas the present models of AQI forecasting are characterized by such limitations as the inaccuracy of the forecast, slowness of its processing, and failure to adapt to the changing pattern of pollution. This study seeks to design a very precise model of predicting AQI with the help of machine learning algorithms, in particular, Random Forest, XGBoost, LSTM, and SVR, so that it could provide real-time predictions, consider the more recent contaminants such as microplastics, and offer practical health advice. The strategy includes collecting historical data and real-time data together at governmental surveillance points, as well as the processing of the data: work with missing values, normalization of measurements, and the extraction of significant characteristics. The parameter tuning of the model optimization uses GridSearchCV with the results as RMSE (4.20), MAE (2.20) and R2 (0.99). The most notable ones are the ability to combine several algorithms using the ensemble technique, time-delayed variables, temporal analysis, and the possibility to combine real-time IoT sensor data with news to find correlations between the events. The user-friendly platform will provide customized health information according to risk factors to each user, including advice on protective equipment, and will support a variety of languages and tailored health-related messages, which will help protect the community health by highlighting the risks of poor air quality and ensure optimal health results.

Peretti, C., Savoia, P.

[Mechanical ventilation as radon reduction strategy: Methodologies for calculating flow rates and field experiences.](#)

E3S Web Conf., Vol. **710**, (2026)

Radon is a naturally radioactive gas that represents a health risk when it accumulates indoors. Controlled Mechanical Ventilation (VMC) is an effective strategy for mitigating radon concentrations, improving indoor air quality, and reducing occupant exposure. The principle on which it is based is the dilution of pollutants, which may include radon. Numerous scientific articles, regulations, and technical documents address the topic of VMC as a strategy for reducing radon concentrations. This study presents a detailed review to highlight critical issues and strategies in the design and management of VMC systems against radon. In addition to the correct determination of flow rates, an important design aspect is the assessment of their imbalance, aimed at creating slight overpressure in the rooms. This article explores methodologies for calculating the ventilation flow rates required for radon remediation, integrating theoretical models with practical field experience. Case studies that illustrate the practical application of these methodologies in real contexts, highlighting the benefits and challenges encountered during implementation, are described. The results show that proper design and management of VMC can significantly reduce radon levels, helping to create healthier and safer indoor environments.

Deshmukh, S. S., Airah, S., Mathew, C., Mccaffery, P., Ross, K., Whiley, H.

[Meeting IAQ requirements in a South Australian canteen environment: reverse cycle versus indirect evaporative cooling.](#)

Ecolibrium. AIRAH, (2026)

Poor indoor air quality is increasingly recognised as a hidden health risk, driving respiratory problems, exacerbating chronic disease, and accelerating the transmission of airborne infections. This study evaluated whether indirect evaporative cooling (EC) systems can improve indoor air quality (IAQ) and

infection control risks compared with conventional reverse cycle (RC) systems. Experiments were conducted in a South Australian canteen during the summer season, selected as a high-occupancy environment with consistent cooking and occupancy conditions across treatments. Occupancy was manually counted with either an indirect evaporative cooling or reverse cycle system operating. The reverse-cycle system consisted of two split systems, neither of which supplied outdoor air – a common scenario in these types of buildings. Indoor air quality parameters such as CO₂, PM_{2.5}, PM₁₀, Total Volatile Organic Compounds (TVOC), temperature, air exchange rate and humidity were measured continuously during operational hours (9am–5pm), capturing peak activity with occupancy sensors.

This project demonstrated that an indirect evaporative cooling system achieved a high air change rate (ACH/h) (13.05/h) and recorded significantly reduced pollutant concentrations in the space compared to when it was operating under reverse cycle conditions. CO₂, PM (particulate matter), and TVOC levels were all statistically significantly lower with the indirect evaporative cooling compared with the reverse cycle ($p < 0.01$), while relative humidity remained within the optimal 40–60% range for infection control and thermal comfort. Spearman’s correlation showed a strong positive relationship between CO₂ and PM and TVOC levels, indicating accumulation at a rate inversely correlated to ventilation effectiveness. Indirect evaporative cooling performance achieved key targets set out under ASHRAE Standard 241, met thresholds in the IAQ blueprint, and the Lancet Commission’s ventilation benchmarks. These results support indirect evaporative cooling as a viable ventilation option for achieving health-based IAQ standards within the built environment, particularly in climate zones conducive to its operation.

Chen, W., Lu, S., Ding, Y., Yu, D., Yuan, J., Chu, S., *et al.*

[Occupant-centric air conditioning control: Fusing multi-modal sensing and probabilistic model prediction.](#)

Building and Environment, Vol. **301**, (2026)

Building air-conditioning systems automatically regulate temperature but cannot autonomously initiate operation based on occupant needs, due to an inability to perceive thermal state and switch-on intention. A predictive model is developed to estimate thermal sensation by fusing physiological signals from the integumentary, cardiovascular, and central nervous systems via XGBoost. A Copula function is further incorporated into the framework to quantify the coupled multivariate influences on switching behavior. This integrated physiological approach surpasses conventional methods in accurately predicting thermal sensation, thereby improving behavioral discrimination. The derived behavioral driving force index enables precise prediction of switch-on intention while reducing the probability of early or late predictions. This probabilistic framework significantly enhances predictive accuracy, paving the way for occupant-centric smart building control.

Ma, Y., Li, A., Han, O., Xiong, J., Bu, B.

[Optimization of indoor airflow distribution for air cleaners using a CFD–random forest approach.](#)

Building and Environment, (2026)

Portable air cleaners are widely used to improve indoor air quality, while their effectiveness strongly depends on the resulting indoor airflow distribution. However, existing studies mainly focus on single-factor analysis, lacking a systematic evaluation of multi-parameter interactions. In this study, a computational fluid dynamics (CFD)-based simulation database was developed by considering five key parameters, including inlet air velocity, inlet type, device placement, air supply angle and air supply mode. The velocity non-uniformity coefficient (R) was adopted as the performance indicator to characterize airflow distribution. A random forest model (RF), supported by permutation importance, bootstrap resampling, and SHAP analysis, was used to rank factor importance rather than as a high-accuracy extrapolative predictor. The importance order was device placement > supply velocity > air-supply mode > supply inlet type > supply angle. An interaction-aware screening method combining RF tree-structure interaction identification with

CFD observation statistics was then used to identify promising parameter combinations. For a 7.80 m × 4.40 m × 3.00 m room, the preferred configuration was C4 placement, front-supply/rear-return mode, 2.5 m/s supply velocity, 0° supply angle, and a swirl inlet. Compared with the conventional case, R decreased from 0.39 to 0.21, and the recirculation area ratio decreased from 16.98% to 0.005%. The proposed CFD–machine learning interaction-aware analysis framework provides a quantitative reference for the optimal design, placement, and operation of portable air cleaners.

K, A., P, Y.

[Parameters That Influence The Pore Size Of Needle Punch Non-Woven Air Filter Fabrics.](#)

International Journal on Science and Technology, Vol. 17, (2026)

Indoor air quality has become a major public health concern due to rising concentrations of particulate matter (PM_{2.5} and PM₁₀), which are linked to respiratory and cardiovascular diseases. The World Health Organization recommends strict limits on PM exposure, increasing the demand for efficient air filtration materials. Needle-punched non-woven fabrics are widely used in commercial air filters due to their cost-effectiveness, mechanical strength, and customizable structure. The pore size of these fabrics—one of the most critical factors governing air filter efficiency—is strongly influenced by manufacturing and structural parameters such as fiber diameter, fabric thickness, bulk density, needle penetration depth, punch density, fiber orientation, and web layering. Increased punch density and deeper needle penetration generally reduce pore size and enhance particle capture. Optimizing these interdependent parameters is essential to achieve a balance between high filtration efficiency, low airflow resistance, and compliance with WHO PM guidelines. This study highlights the key variables controlling pore structure in needle-punched non-woven air filter fabrics and their impact on overall filtration performance.

Tengfei (Tim) Zhang, F. L.

[Particle Filtration and Indoor Air Cleaning.](#)

In: *Indoor Aerosol Dynamics*. 2026. 271-289 p.

Summary When the indoor aerosol concentration is above the prescribed limit, the concentration must be lowered through filtration. This chapter addresses particle filtration by fiber filters and electrostatic precipitators (ESPs), including their basic principles, performance evaluation models, and guidelines for operation. The particle collection efficiency for fiber filters due to interception, inertia impaction, Brownian diffusion, gravitational settling, and electrostatic attraction is described in detail. Performance of ESPs, in terms of the electric field they create, the particle migration velocity, and the particle collection efficiency, is introduced as well.

Rodríguez-Alhambra, A., Mirea, T., Hervás-García, R., Jaldo, E., Fortín, R., Olivares, J., *et al.*

[Pentacene based Solidly Mounted Resonators for Toluene detection: influence of operating frequency and readout parameters.](#)

2025 IEEE International Ultrasonics Symposium (IUS)

Volatile organic compounds (VOCs) such as toluene represent a major source of indoor air pollution, with significant adverse effects on human health even at low concentrations. The development of sensitive, selective, and low-power detection technologies is therefore of considerable importance. In this study, AlN-based solidly mounted resonators (SMRs) operating at 2.8 GHz and 5 GHz were functionalized with a 50 nm pentacene layer to evaluate their performance as toluene sensors. The devices exhibited stable resonance characteristics and clear frequency shifts upon exposure to toluene vapors. Sensitivities of –50 Hz/ppm and – 218 Hz/ppm were obtained for the 2.8 GHz and 5 GHz SMRs, respectively, consistent with

the frequency dependence of acoustic mass loading and outperforming other toluene FBAR sensors functionalized with polymers. Systematic analysis of readout parameters demonstrated that fitting-based peak extraction significantly reduces noise, achieving sub-kHz resolution. These findings establish pentacene-coated SMRs as promising candidates for room-temperature VOC detection and provide guidelines for optimizing measurement strategies in high-frequency electroacoustic sensors.

Li, C., Quan, Z., Deng, Y., Zhao, Y.

[Performance analysis and optimization of the MHPA-BIPVT air-cooled curtain wall fresh air system.](#)

Energy and Buildings, Vol. **363**, (2026)

Building-integrated photovoltaic-thermal (BIPVT) technology is a pivotal enabler for zero-carbon buildings. However, PV modules serving as building envelope elements face a persistent thermal dilemma: balancing heat dissipation for electrical efficiency with thermal insulation to minimize HVAC loads. To resolve this, this study proposes an air-cooled micro heat pipe array-based BIPVT (MHPA-BIPVT) curtain wall system seamlessly integrated with building fresh air ventilation. This configuration enables three seasonally adaptive functions: year-round electricity generation, winter fresh air preheating, and summer active PV dissipation. A transient thermoelectric model was developed using the lumped parameter method and bidirectionally coupled with building thermal and fresh air system models in TRNSYS to facilitate high-fidelity hourly simulations. Using a public building in Tianjin, China, as a case study, the impacts of air duct geometry (single-, double-duct, and double-row double-duct) and distribution configurations on thermoelectric output, pressure drop, and system energy efficiency were systematically investigated. Results demonstrate that the double-row double-duct (DRDD) configuration achieves the highest net thermoelectric gain, with optimal airflow rates of 36 m³/(h·m²) in winter and 16 m³/(h·m²) in summer. Among the evaluated configurations, the 5-series 6-parallel (5S6P) configuration yields the optimal trade-off between fan energy consumption and thermal benefits, achieving a net power gain of 6203.51 W and an energy efficiency coefficient (EEC) of 20.73 on a typical winter day. Throughout the heating season, the system recovers 142.36 kWh/m² of thermal energy, satisfying 17.99% of the building's fresh air heating load—a 20%-36% improvement over conventional air-cooled BIPVT systems. In the non-heating season, active dissipation reduces average PV temperatures by 8.36 °C, enhancing electrical output by 2.21%. The system achieves an annual CO₂ emission reduction of 13.62 tCO₂, demonstrating tangible decarbonization potential at the building scale. This work uncovers the interdependent coupling mechanisms within MHPA-BIPVT façades and establishes a physics-informed optimization framework for high-performance, zero-carbon-ready building envelopes.

Merhaby, D., Baudelocque, H., Simon, S.

[Qualité de l'air et santé au travail : stratégie de prévention intégrée.](#)

Archives des Maladies Professionnelles et de l'Environnement, Vol. **87** n°(3), (2026)

La qualité de l'air intérieur (QAI) constitue un enjeu majeur pour la santé au travail. Les salariés passent plus de 90 % de leur temps dans des espaces clos, où ils peuvent être exposés à différents polluants (COVt, particules fines, CO₂...). Une mauvaise QAI peut avoir des effets sur la santé, le bien-être et la concentration. Pour répondre à ces enjeux, l'efficiencia a mené une campagne de prévention entre décembre 2025 et avril 2026, avec une approche intégrée santé et environnement. Cette démarche visait à sensibiliser les équipes internes d'Efficiencia, ainsi que les employeurs et salariés des entreprises adhérentes disposant de locaux à pollution non spécifique, aux sources de pollution intérieure et aux bonnes pratiques. La campagne a combiné des visites de locaux, des diagnostics des sources de pollution, un kit de sensibilisation, des mesures à l'aide de capteurs intelligents connectés (COVt, particules fines PM 10, PM 2,5, PM1, CO₂, température, humidité, luminosité, bruit) ainsi qu'un recueil des perceptions et de la satisfaction auprès des occupants et des employeurs. Cette approche croisée a permis d'associer données objectives et ressenti des personnes. Les résultats préliminaires montrent que les niveaux de polluants

sont globalement conformes aux seuils recommandés. Toutefois, des pics ponctuels de COVt ont été observés, en cas de ventilation insuffisante, forte occupation des locaux et/ou lors de certaines activités (utilisation de produits chimiques, nettoyage, impression de documents, etc.). La température et l'humidité influencent également la qualité de l'air, soulignant l'importance d'une gestion globale de l'environnement intérieur. Les résultats définitifs en fin de campagne apporteront plus de précisions. Grâce à l'accompagnement des préventeurs d'efficience, les employeurs ont pu bénéficier de recommandations concrètes : amélioration du renouvellement d'air, adaptation de la ventilation, réduction des sources de pollution et sensibilisation à la qualité de l'air intérieur, tout en restant efficace, efficient et innovant. Cette démarche globale contribue à renforcer la prévention, améliorer le confort des occupants et soutenir la performance et la santé au travail.

Peretti, C., Di Loreto, S., Filippini, F., Bagagli, M.

[Radon monitoring in public buildings: Compliance with the ITACA D.1.5 criterion in Bolzano.](#)

[E3S Web Conf.](#), Vol. **710**, (2026)

Radon represents a significant health risk to indoor air quality in buildings located in radon-prone areas. The ITACA Protocol (criterion D.1.5) establishes strategies to control radon migration from soil, setting the maximum level at 200 Bq/m³ as an annual average value. Monitoring is essential to verify compliance with criteria and ensure healthy indoor environments in public buildings. This study presents radon concentration monitoring in public buildings in Bolzano, an area with radon risk predisposition. The objective is to quantify radon levels in ground-floor and basement spaces, evaluate ITACA compliance, and identify the effectiveness of implemented migration control strategies (passive or active depressurization). The methodology includes continuous annual measurements conducted in lower floor areas with higher occupancy factors, according to ITACA guidelines. Preliminary results demonstrate radon concentration variations across monitored buildings and the effectiveness of adopted mitigation systems. The analysis verifies compliance with ITACA standards (200 Bq/m³) and evaluates migration control strategy performance under alpine climatic conditions. The conclusions provide guidance for achieving optimal ITACA levels, emphasizing the importance of continuous monitoring and integrated strategies.

Drescher, F., Niessner, J., Daniels, A., Marsden, N.

[Raumluftqualität verstehen und gestalten: Erkenntnisse zu Wissenslücken, Einstellungen und Lüftungsverhalten als Ansatzpunkte für gesunde Innenräume \(Understanding and improving indoor air quality: insights into knowledge gaps, attitudes, and ventilation practices as leverage points for healthy indoor environments\).](#)

[Prävention und Gesundheitsförderung](#), (2026)

The aim of this study is to describe public knowledge and attitudes related to indoor air quality as well as ventilation behavior and changes since the pandemic to identify leverage points for behavioral interventions. Methods In February 2025, 1902 people were surveyed nationwide using a standardized questionnaire via an online panel. The composition of the sample is largely comparable to the sociodemographic characteristics of the German population. Results Indoor air quality is considered important by a clear majority of 93%, yet there are gaps in knowledge regarding specific influencing factors such as various pollutants. Regarding ventilation habits, for example, the frequency is too low: Only about one in ten people ventilate several times an hour, while the majority ventilate several times or once a day. Indoor air quality monitors are not widely used. Furthermore, more than two-thirds do not use monitors or are unaware of them; where they are available, they support measurement-based ventilation habits. Conclusion The findings reveal a clear gap between attitudes and actual behavior and highlight the need for everyday, structurally embedded interventions. To sustainably improve indoor air quality, a combination of targeted knowledge transfer, the establishment of simple ventilation routines, and technical support through monitoring and feedback systems appears appropriate.

Lu, M.-J., Wang, C.-L., Nguyen, M.-K., Tran, V.-N., Li, I. C., Nguyen, H.-P., *et al.*

[Recent Advances in SiO₂ Nanofiber Membranes for High-Efficiency Air Pollutant Removal: A Mini Review.](#)

Aerosol and Air Quality Research, (2026)

Air pollution from industrial exhaust and mobile sources continues to threaten human health and ecosystems, creating demand for air-cleaning technologies that operate reliably under elevated temperatures and corrosive environments. Conventional polymer-based filter media often degrade under such conditions, limiting their applicability in industrial exhaust treatment. Electrospun silica nanofiber (SiO₂ NF) membranes and SiO₂-based ceramic nanofibrous membranes have emerged as robust alternatives because of their thermal stability, chemical resistance, and mechanical durability. Beyond particulate capture, functionalization of SiO₂ NFs through metal-oxide incorporation, MOF-based modification, and surface chemistry tuning enables multifunctional pollutant removal by enhancing adsorption and catalytic conversion of gas-phase species. This mini-review summarizes recent advances in functionalized SiO₂ nanofibrous membranes, with emphasis on structure–property–performance relationships and functionalization strategies for multi-pollutant control. The influence of key operating conditions, including temperature and humidity, on filtration behavior is also discussed. Remaining challenges related to fabrication complexity, performance trade-offs, and long-term stability are highlighted, together with directions for improving scalability and durability. These insights provide a basis for advancing SiO₂ NF membranes toward practical applications in industrial exhaust treatment and indoor air purification.

Walton, F.

[The Role of Smart Building Technologies in Enhancing Occupant Comfort and Psychological Wellbeing.](#)

Research Gate, (2026)

This study investigates the role of smart building technologies in enhancing occupant comfort and psychological wellbeing, using a longitudinal mixed-methods design across 24 commercial office buildings (12 smart-enabled, 12 conventional control buildings) in North America and Europe over 24 months. The research evaluates five smart technology clusters: (1) personalized environmental control systems (zonal HVAC, task lighting, automated shading), (2) indoor environmental quality (IEQ) monitoring and real-time feedback (temperature, humidity, CO₂, particulate matter, volatile organic compounds, noise), (3) biophilic and circadian lighting systems (dynamic correlated color temperature, daylight harvesting, tunable white), (4) occupancy and space utilization analytics (desk booking, wayfinding, quiet zone management), and (5) occupant feedback and adaptive building systems (push notifications, preference learning, automated adjustments).

Gandini, J.

[Sensible heating and cooling of indoor building spaces by eliminating local in-room humidity condensation \(and the related drain pans and drainage pathways\) by using calibrated humidity in air-renewal fan coil systems, for healthier NZEB, ZEB and ZCB.](#)

E3S Web Conf., Vol. **710**, (2026)

The transition towards Nearly Zero Energy Buildings (NZEB), Zero Energy Buildings (ZEB) and Zero Carbon Buildings (ZCB) requires rethinking conventional HVAC approaches to indoor thermal and hygrometric control. Traditional fan-coil or split systems often rely on latent heat removal through local condensate formation, which introduces hygiene risks due to microbial potential proliferation in condensate trays and drains. As buildings continue to be designed for lower energy use, the sensible heating and

cooling opportunity presents a feasible opportunity for systems that use, at room-by-room level, sensible-only heating and cooling equipment. Examples may include: radiant cooling panels (or tubing embedded in the building structure), chilled beams and fan coils terminal units with sensible-only cooling coils. While traditional radiant panels are encountering difficulties to manage the inertia effects into a NZEB, ZEB or ZCB and chilled beams, which need to be fixed on the ceiling, sometimes are not finding sufficient space to be installed in modern buildings, the sensible heating and cooling fan coil option is becoming a very interesting possibility.

Parkinson, T., Bhangar, S., Chan, W. R., Chen, W., Gilligan, B., Kramer, T., *et al.*

[Ten questions concerning low-cost indoor air quality sensors: Perspectives from research and practice.](#)

Building and Environment, Vol. **300**, (2026)

Low-cost indoor air quality (IAQ) sensors are increasingly being used in homes and commercial and public buildings, driven by growing concerns about the impact of air on health, cognitive performance, and occupant wellbeing. These sensors offer a potentially transformative opportunity to increase spatial and temporal coverage of IAQ monitoring at a fraction of the cost of conventional reference instruments. However, their widespread use raises questions around accuracy, calibration, placement, data handling and interpretation, and integration into existing standards and workflows. This paper presents ten critical questions concerning the use of low-cost IAQ sensors in buildings, drawing on the latest empirical research, field deployments, and emerging practice. It discusses potential frameworks for deployment and evaluation, examines current sensor capabilities for measuring common pollutants, identifies methodological gaps in validation and uncertainty quantification, and outlines the extent to which existing IAQ standards can accommodate sensor-based evidence. The paper also explores how monitoring needs and deployment models vary by building type, the potential of real-time IAQ data to support building operations, and the ethical and legal implications of widespread sensor use. While significant challenges remain in ensuring data quality and building stakeholder trust, new applications are emerging through open data initiatives and advances in analytics and visualization. As the technology, science, and standards co-evolve, low-cost IAQ sensors are poised to become integral to routine building operation, building science, and environmental health research.

Iatauro, D., Lavinia, C., Nardi, I., Sannino, R.

[Thermal comfort strategies and energy implications in office buildings: A case study.](#)

E3S Web Conf., Vol. **710**, (2026)

The revised Energy Performance of Buildings Directive (EPBD IV) highlights the importance of ensuring adequate levels of indoor comfort and air quality in the context of energy retrofit, addressing building energy audits toward energy efficiency solutions while enhancing occupants' environmental conditions. In this framework, the present article analyses the energy implications of potential retrofit strategies for a case study building, previously subject to extensive thermal comfort monitoring, by applying the dynamic hourly calculation method given by UNI EN ISO 52016-1:2018. Starting from results of the monitoring campaign, the building energy demand was estimated by modeling different indoor thermal zones, to obtain a more detailed representation of the building thermal behaviour. On this basis, several retrofit scenarios, focused on building envelope and Heating, Ventilation, and Air Conditioning (HVAC) systems, were assessed and compared in terms of their impact on overall energy performance as well as on indoor thermal comfort conditions. The results show that the proposed measures can lead to different impacts on building energy demand, primary energy consumption and thermal comfort conditions. Overall, the study highlights that the integration of comfort analysis into energy audits can support the definition of more balanced and effective retrofit strategies, improving energy performance and occupants' satisfaction.

Ramadan, M. N. A., Ali, M. a. H., Ghazali, N. N. N., Jaber, H., Rayash, A. A., Ghazal, M., *et al.*

[A transfer-federated learning framework integrating toxicological risk modeling for heterogeneous UAV, UGV, and IoT air-quality monitoring.](#)

Alexandria Engineering Journal, Vol. **145**, (2026), 295-312 p.

Existing air quality monitoring systems rely on static sensors, failing to capture personal exposure dynamics and hindering secure cross-platform data sharing. To address these limitations, this study introduces a novel Transfer-Federated Learning (TFL) framework for collaborative learning among heterogeneous devices—an unmanned ground vehicle (UGV), an unmanned aerial vehicle (UAV), and fixed IoT stations—while preserving data privacy. The TFL approach uniquely adapts a pretrained model to clients with different sensor configurations through layer-wise transfer and FedAvg aggregation. Lightweight models (Tiny-TCN, TFT-lite) predict both pollutant concentrations (PM_{2.5}, PM₁₀, CO₂, CH₂O, VOCs) and mechanistic toxicological risks (inhalation dose and hazard quotient). Field tests across three industrial sites demonstrated high cross-platform accuracy (global R² = 0.984) and real-time inference (<2 s), reducing personal exposure estimation error by over 40% compared to static fixed-sensor baselines. The core contribution lies in the system-level integration of transfer learning and federated learning across heterogeneous platforms, with toxicological metrics used to translate predictions into actionable occupational risk indicators. This work establishes a new paradigm for privacy-preserving, health-aware monitoring in industrial environments.

Križaj, J.

[Učinkovitost decentralnega prezračevanja v resničnem okolju \(Effectiveness of decentralized ventilation in a real environment\).](#)

Univerza v Ljubljani, Fakulteta za strojništvo. Thèse 2026

The final thesis deals with the efficiency of decentralized ventilation and its impact on indoor air quality in a room. Due to the increasing airtightness of buildings, ensuring adequate ventilation is becoming crucial for maintaining appropriate indoor air quality and the health of occupants. In the thesis, an experimental study was conducted on a building to investigate the effectiveness of pollutant dilution under different operating conditions of a decentralized mechanical ventilation system with heat recovery. Based on carbon dioxide measurements under various operating conditions, an analysis of ventilation was performed and the air exchange rate in the room was determined. The influence of air mixing and its effect on ventilation efficiency and the performance of the ventilation unit were also analyzed.

Hamid, E. A., Ahmad, S., Kamaludin, N. F., Ithnin, A., Awang, N.

[Volatile Threats in Hospital Indoor Air: Exceeding TVOC Thresholds and The Role of Ventilation Strategy.](#)

ORIENTAL JOURNAL OF CHEMISTRY, Vol. **42** n°(2), (2026), 382-390 p.

Healthcare workers and patients are increasingly exposed to total volatile organic compounds (TVOC), an often-overlooked hazard that threatens hospital air quality, occupational health, and clinical safety. Total volatile organic compounds (TVOC), originate from disinfectants, cleaning products, and medical procedures, contributing to cumulative chemical exposure in healthcare settings. This study investigated TVOC concentrations and their temporal and ventilation-related variability across eleven hospital wards in Klang Valley, Malaysia. Real-time monitoring was performed under natural and mechanical ventilation during morning and evening sessions. Data were analyzed using Kruskal-Wallis, Mann-Whitney, and multiple regression methods. TVOC concentrations ranged from 24.8-545.0 ppm, exceeding the ICOP (IAQ) 2010 limit (3 ppm). Emergency and surgical wards with mechanical ventilation demonstrated the highest pollutant burdens, while wards with natural ventilation exhibited significant dilution between morning

and evening measurements. Regression analysis revealed temperature as a negative predictor ($\beta = -15.57$, $p = 0.048$) and carbon monoxide as a positive predictor ($\beta = 50.10$, $p = 0.026$). These findings present critical evidence that the type of ventilation and diurnal airflow dynamics have a pervasive impact on VOC accumulation, simultaneously indicating an urgent need for ongoing IAQ surveillance, improved HVAC design, and targeted ventilation strategies to ensure the safety of hospital occupants.

Petite, P., Polish, H. G., Gel, E. S.-O., Gel, D. F. B., Acrylgel, P., Gel, P. T., *et al.*

[What You're Actually Breathing at the Nail Table—and Why It Matters for Everyone in the Room.](#)

Ikoniqnails. 2026

When customers walk into a nail salon, they're expecting somewhere relaxing. What they're often getting—and what the technician sitting opposite them breathes for eight hours a day—is a measurable mixture of fine dust, solvent vapours, heavy metals, microplastics, and chemicals that have shown up in workers' urine and breathing-zone air samples by the end of a shift. This isn't an opinion. It's what the published research now consistently shows.

Over the last decade, researchers in Boston, Los Angeles, New York City, Tehran and Michigan have stopped guessing and started measuring. Air monitors went into real salons. Dust was collected from real nail tables. Blood and urine samples came from real technicians before and after shifts. The picture that emerged is consistent, and it carries a clear message for anyone who works in or visits a salon: the air matters, and most salons can do better.

[Wireless Air Quality Monitoring System.](#)

International Journal of Latest Technology in Engineering Management & Applied Science, Vol. 15 n°(4), (2026), 244-253 p.

This The Wireless Air Quality Monitoring System is designed to monitor environmental conditions in real time using IoT technology. The system detects harmful gases present in the air using gas sensors. It also measures temperature and humidity using appropriate sensors. An ESP8266 microcontroller is used to process the collected data efficiently. The system continuously compares gas levels with predefined safe limits. When the gas concentration exceeds the threshold, a buzzer is activated to alert users immediately. The processed data is transmitted wirelessly using Wi-Fi technology. Users can monitor real-time data through the Blynk IoT mobile application. The system is cost-effective, easy to install, and suitable for both indoor and outdoor environments. Overall, this project provides a reliable solution for improving safety and environmental monitoring.
