Bulletin de veille QAI
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Objectif : *Qualité de l'air intérieur*

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Google Scholar, Lens, WoS

Salagnat, L. É.

Air Quality In Veterinary Clinics: Perspectives, Challenges And Solutions.

EUVG - Escola Universitária Vasco da Gama. Thèse 2024

Air quality in veterinary clinics is vital for the welfare of medical staff, animals and clients. This review aims at presenting an overview of air quality pollutants most common in veterinary facilities, their effects on health, sources of indoor air pollutants, and current control measures. Biological aerosols, ultrafine particles, and chemical agents such as volatile organic compounds and polycyclic aromatic hydrocarbons are important pollutants in the veterinary clinics. Polluted air is known to worsen respiratory and cardiovascular diseases in both animals and humans, thus underlining the importance of air quality control. The review also looks at current legislation and best practices in regulation and guidelines such as those of the European Union and offers new ideas and technologies to improve air quality. It also brings comparison between air quality in veterinary clinics and human hospitals to put into perspective. Techniques for evaluating air quality for example by using bioaerosol sampling and chemical analysis are presented albeit expensive and impractical. The focus is on increasing the fresh air exchange rates, controlling the sources of pollution, and using environmentally friendly disinfectants. The review ends with the discussion of the existing research limitations and directions for future research opportunities, such as technology development and bioremediation. In conclusion, this review seeks to provide a useful direction in the formulation of effective recommendations of enhancing the quality of indoor air in veterinary healthcare facilities.

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Cheng, S., Yan, S., Yan, Z., Wu, T.

Air quality monitoring system based on STM32.

2024 6th International Conference on Intelligent Control, Measurement and Signal Processing (ICMSP)

In daily life, air quality has a great impact on human health. Based on the current demand for indoor air quality, an indoor air quality monitoring system is designed. The system can monitor PM2.5, formaldehyde and temperature and humidity values in the air. This design uses STM32F103C8T6 minimum system as the main control chip, through the temperature and humidity sensor DHT11, formaldehyde sensor ZE08-CH2O and particulate matter sensor GP2Y1014AU for data monitoring, 0.96 inch OLED display display data in real time. Through TTL to RS485 module and RS485 to USB communication with the host computer, convenient for users to understand the indoor air quality in real time.

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Kim, Y.-G., Kim, S.-B.

An Analysis of Indoor Air Quality in Community Facilities in Rural Areas.

Journal of Korean Society of Rural Planning, Vol. **30** n°(4), (2024), 209-217 p.

The purpose of this study analyzed the indoor air quality of the residents' daily exchange space and diagnosed pollutants as an on-site survey of small community facilities in rural areas. The physical survey of community facilities was conducted on the year of approval of use, housing shape, wall material, area, and the number of people staying at all times, and the pollutants in the indoor space were investigated. Fine dust (PM10), Ultrafine dust (PM2.5), HCHO, TVOC were measured for indoor air quality pollutants in community facilities. It was found that 86.3% of the buildings were built on the structure and material type of community facilities, and 65% of the facilities that were aged "more than 25 years", and the approval year

for use was about 25 years old. Depending on the size of the community facilities and the number of households in the administrative district, there was a large variation, and the density of occupants using community facilities was found to be 7.6m2/person. As a result of measuring the indoor air quality of community facilities, it was analyzed that the use of periodic natural ventilation and air purifiers was more related to indoor air quality maintenance, rather than the difference in pollutant concentration due to the physical aging relationship between old and new buildings. The concentration of fine dust was distributed between 8μg/m3 and 70.7μg/m3 of the multi-use facility maintenance standards used by the vulnerable group, and the concentration of ultra-fine dust exceeded the concentration of 36.7μg/m3 to 42.7μg/m3 in four places that exceeded the attraction standard. The pollution concentration of HCHO was between 10μg /m3 and 960μg/m3, and the concentration of 210μg/m3 to 960μg/m3 was exceeded in four places that exceeded the maintenance standard. The pollution concentration of TVOC was between 60μg/m3 and 3,350μg/m3, and the concentration of 790μg/m3 to 3350μg/m3 was exceeded in four places that exceeded the maintenance standard.

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Gerba, C. P., Wadhwani, D.

The Case for an Indoor Air Quality (IAQ) Index in Health Care.

Infection Control Today, (2025)

Evolving air quality monitoring technologies, like an IAQ Exposure Index, provide real-time data to detect airborne contaminants, enhance infection control, and protect vulnerable healthcare populations from respiratory exposures.

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Chen, F., Hou, Y., Yuan, X., Fang, Z., Cheng, W., Wang, J.*, et al.*

Characteristics of airflow under stratum ventilation induced by fabric air dispersion system with orifices.

Journal of Building Engineering, Vol. **102**, (2025)

As a new ventilation terminal, Fabric air dispersion system (FADS) has characteristics with easy to clean and low ceiling weight load. However, it has still been unknown about the flow mechanism of air induced by FADS with orifices. In present work, the direct description method proposed in our previous work is employed to establish the numerical model of FADS with orifices under the stratum ventilation (SV), and the research is focused on the distribution of air velocity and pressure through the FADS' cavity, indoor air velocity and temperature, thermal comfort. Meanwhile, the simulation results are validated by experimental results and visualization using a smoke generator. Results demonstrate that the simulation method based on the direct description method, firstly, is feasible to precast the air characteristics under SV mode induced by FADS with orifices. Secondly, the discharge of airflow supplied by FADS with orifices is mainly dominated by the ratio of static pressure to dynamic pressure, which also determines the deflection of ejection airflow and is affected by orifice diameter. Thirdly, strategy of SV induced by FADS with orifices can supply the fresh air into occupant's breath zone with a vertical indoor air temperature difference of less than 3 K. In future work, we will experimentally investigate the characteristics of SV on FADS with orifices such as indoor air distribution, ventilation efficiency and energy saving. Research results would help optimize strategy of SV based on FADS with orifices and expand its implementation in real project.

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Megalingam, R. K., Vadivel, S. R. R., Kotaprolu, S. S., Nithul, B., Kumar, D. V., Rudravaram, G.

Cleaning Robots: A Review of Sensor Technologies and Intelligent Control Strategies for Cleaning.

Journal of Field Robotics, (2025)

ABSTRACT Cleaning robots have revolutionized the way spaces and surfaces are cleaned, accessing areas that are often difficult for humans to reach. A significant segment of the cleaning robot industry is dedicated to home cleaning robots, which have undergone numerous enhancements since their initial introduction. Through extensive research and development efforts, the application scope of cleaning robots has expanded beyond floors to encompass walls, staircases, pools, tanks, ventilation ducts, windows, and other surfaces. These robots have seen improvements in cleaning effectiveness through the integration of new designs, technologies, and control methods. This review paper presents a comprehensive analysis of cutting-edge cleaning robots recently developed, exploring various sensor technologies and intelligent control strategies employed to enhance cleaning efficiency. Additionally, the paper discusses the challenges associated with deploying these robots in real-world scenarios.

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Avci, A. B.

Comparative analysis of natural and mechanical ventilation strategies for glass-partitioned office spaces using CFD and empirical validation.

Journal of Building Engineering, Vol. **103**, (2025)

Ensuring optimal thermal comfort and indoor air quality (IAQ) in office environments is critical for maintaining occupant well-being and productivity. This study aims to compare natural and mechanical ventilation strategies in glass-partitioned office spaces to evaluate their impact on thermal comfort and CO2 concentrations. Computational fluid dynamics (CFD) simulations were conducted and validated using empirical field data collected from an office in Izmir, located in a Mediterranean climate. The research focuses on understanding the impact of seasonal variations, ventilation methods, and inlet vent dimensions on thermal comfort and IAQ, specifically CO2 concentrations. A glass-partitioned workspace within the office was monitored, and the collected data were replicated in the CFD model for validation. After validation, new scenarios were developed using a 3 × 2 × 2 unbalanced full factorial design. The findings reveal that mechanical ventilation, particularly when combined with larger inlet vent diameters, significantly improves CO2 levels and thermal comfort, with CO2 concentrations reduced from 1679 ppm to 639 ppm and thermal comfort levels nearing neutral sensation (PMV: 0.01) during summer. These findings highlight the necessity of higher fresh air supply velocities with larger vent dimensions to address the challenges of maintaining optimal IAQ and thermal comfort in glass-partitioned office environments. Unlike previous studies that primarily focus on open-plan offices, this research specifically investigates ventilation challenges in glass-partitioned office spaces, providing a deeper understanding of air distribution and thermal comfort optimization. The results provide guidance for building designers and engineers aiming to enhance occupant well-being and productivity in partitioned open-plan office spaces.

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Chun, H., Song, M. Y.

Comparative analysis of the concentrations of TVOCs, Aldehydes, and PAHs in public and commercial kitchens in Korea.

Air Quality, Atmosphere & Health, (2025)

Public and commercial kitchens in Korea operate differently; however, there have been no systematic studies comparing volatile organic compounds (VOCs) concentrations in different types of cooking facilities. We compared compound concentrations between public and commercial kitchens in Korea through online monitoring of VOCs and analyzing the total VOCs (TVOCs), aldehydes, and polycyclic aromatic hydrocarbons (PAHs) generated during cooking. Real-time monitoring was conducted in three public and three commercial kitchens. High peak occurrences were more frequent during cooking in commercial kitchens. An additional analysis of TVOCs and aldehydes conducted during cooking in four public and four commercial kitchens revealed that the average TVOCs concentration was 4.6 times higher in public kitchens. In contrast, concentrations of formaldehyde and acetaldehyde were 1.5 and 1.4 times higher in commercial kitchens, respectively. PAHs analysis detected 37 compounds were detected in both public and

commercial kitchens. The total PAHs concentration was 1,162.6 ng/m3 in commercial and 326.8 ng/m3 in public kitchens. Concentrations of carcinogenic and priority management PAHs were elevated in commercial kitchens, with benzo[a]pyrene being 1.4 times higher in commercial kitchens than in public kitchens. Our results suggest a higher health risk in commercial than in public kitchens, emphasizing the need to identify and control pollutants generated during cooking.

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Huang, Z., Li, Q., He, Y., Ding, X., Dong, Y., Gao, W.

Coupled heat and mass transfer analysis for indoor air quality and thermal comfort in naturally ventilated offices.

Applied Thermal Engineering, Vol. **269**, (2025)

Multiple discrete heat and pollution sources have a significant impact on the thermal comfort and indoor environment of naturally ventilated offices. Based on the heat-mass coupling mechanism, Computational Fluid Dynamics (CFD) numerical simulation combined with measurements were used to evaluate the influencing factors such as equipment load, inlet air temperature and ventilation strategy. Furthermore, key indicators such as air diffusion performance index (ADPI), air exchange efficiency (AEE) and pollutant removal rate (PRR) were quantified to analyze the thermodynamic coupling relationship between indoor airflow, temperature field and pollutant concentration field. The results show that from the perspective of heat transfer, when the indoor temperature is significantly higher than the outdoor temperature (ΔT = 4 °C), buoyancy-driven natural convection dominates the flow, enhancing air exchange while causing uneven temperature distribution that can reduce thermal comfort. Under strong buoyancy, pollutants such as CO2 rise with the warm air, leading to clear stratification in the upper part of the room. In contrast, a slight negative temperature difference (ΔT = –1.6 °C) causes cold air to sink, which suppresses natural convection. This results in localized heat accumulation, air stagnation, and the buildup of pollutants near the floor. From a mass transfer perspective, the heat output from equipment primarily affects the temperature field and has minimal impact on airflow velocity. Global sensitivity analysis (GSA) identifies the ΔT as the primary factor influencing thermal comfort (PMV), followed by CO2 concentration. Moreover, the combined effect of door and window openings (θw, θd) contributes up to 68 % of the PRR, emphasizing the importance of balanced ventilation to maintain effective diffusion. The research results provide a scientific basis for optimizing thermal comfort and pollutant control in natural ventilation environments.

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Zhang, W., Yu, Y., Yuan, Z., Tang, P., Gao, B.

Data-driven pre-training framework for reinforcement learning of air-source heat pump (ASHP) systems based on historical data in office buildings: Field validation.

Energy and Buildings, Vol. **332**, (2025)

Reinforcement Learning (RL) has demonstrated potential for optimal control of Heating, Ventilation, and Air Conditioning (HVAC) systems. Current research on RL in HVAC systems control is limited to simulation studies, with few real-world deployments that have minimal focus on supply-side optimization, along with a reliance on building simulation tools for pre-training. This paper proposes a practical data-driven pre-training framework for Air-Source Heat Pump (ASHP) system. The framework integrates data-driven models based on real-world historical data for load forecasting, equipment energy consumption, and heat transfer. As a case study, two classic value-based reinforcement learning agents, Q-learning and Deep Q-Network (DQN), were selected to dynamically control the number and frequency of pumps and the supply water temperature based on the fluctuating outdoor dry bulb temperature and building cooling load. The pre-training results indicate that DQN achieved energy-saving rates of 4.70% for the training data and 4.65% for the testing data, while Q-learning performed at -0.66% and 1.28% respectively, indicating that both agents outperformed historical control strategies, thereby demonstrating the effectiveness of the pre-training framework. After pre-training, each agent was deployed back into the real-world system for two days of field validation. During deployment, both agents outperformed the rule-based control, with DQN

achieving an energy-saving rate of 9.28% and Q-learning achieving 9.04%, demonstrating that the proposed framework enables RL agents to continue real-world learning with an enhanced control strategy. This study provides a novel pre-training paradigm for implementing RL agents in supply-side control of HVAC systems, potentially enhancing both RL deployment and its online evolution.

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Dave, R. D.

Design and Analysis of Dehumidifier to Improve Air Quality.

International Journal of Innovative Research in Engineering and Management, Vol. **11** n°(4), (2024)

Compressed air is used for obtaining brake application in which brake pipe and feed pipe run throughout the length of the coach. Brake pipe and feed pipe on consecutive coaches in the train are coupled to one another by means of respective hose couplings to form a continuous air passage from the locomotive to the rear end of the train. Compressed air is supplied to brake pipe and feed pipe from locomotive also the magnitude of braking force increases in steps with the corresponding reduction in brake pipe pressure. So due to brake binding and brake failures due to pressure drop and high moisture rate so there was need of dehumidifier because of less moisturized air. When passed to braking system it will help the braking system and there will be less brake binding and pressure failure in braking system so with the help of dehumidifier, we can reduce moisture content and pass dry air to the braking system and increase good braking effect and decrease maintenance. As per the result of dehumidifier we have decreased moisture content up to 81.08% and decreased maintenance life by 120 days also this dehumidifier is less small in size than the prior one. From obtained moisture content of 37%, we have decreased it to 7%. Also, it is more efficient to replace silica gel easily in this dehumidifier.

https://doi.org/10.55524/ijirem.2024.11.4.7

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Safdar, S. M. R., Uchil, S. I., Safeer, M., Raifhan, M., Mokashi, I., Delvi, M. K.

Design and Fabrication of a Low-cost Air Purifier.

Journal of Advancement in Machines, Vol. **10** n°(1), (2025), 18-27 p.

This project presents the design and development of a low-cost air purifier to address the affordability and accessibility challenges associated with commercial air purification systems. The proposed purifier utilizes a custom-designed filter and a low-power fan to effectively remove airborne pollutants, including fine particulate matter and allergens. The device is designed to be affordable, energy-efficient (<20W), and quiet (<40 dB), ensuring minimal operational costs while maintaining effective air purification performance. The compact and user-friendly design makes it suitable for residential use, particularly in economically disadvantaged communities where indoor air pollution is a pressing issue. By providing an accessible and cost-effective solution, this project aims to bridge the gap in clean air accessibility, reduce health risks associated with poor indoor air quality, and promote overall well-being. Future research can focus on enhancing filtration efficiency, integrating sustainable and biodegradable filter materials, and incorporating smart monitoring systems to optimize performance and user experience.

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Raja Amelia, L., Pangaribuan, H.

Design et implementation of arduino-based indoor air quality monitoring system.

Computer and Science Industrial Engineering (COMASIE), Vol. **12** n°(3), (2025), 118-127 p.

In this research, a prototype is designed to detect indoor air quality. The designed system will display indoor air quality data on an LCD screen and provide a warning via a buzzer if the air quality reaches an unhealthy threshold. The LED indicator will light up as a visual indication of the air quality based on the

concentration of detected pollutants, such as dust particles, harmful gases, temperature, and humidity. The MQ-135 sensor is used to detect harmful gases such as carbon dioxide that can affect air quality. The GP2Y1010AU0F sensor is used to detect particles, while the DHT22 is used to measure temperature and humidity. In the final stage, conclusions will be drawn based on the results of the system tests that have been carried out. It is hoped that through this research, the developed system can provide solutions to indoor air quality problems and contribute to creating a healthier environment for residents.

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Anzum, A., Rana, M. J., Ahmed, E., Rahman, S.

Determining the optimal window size and orientation of an academic building in subtropical climate.

International Journal of Building Pathology and Adaptation, (2025)

The major goals of this study are to investigate the existing state of affairs concerning daylighting, glare and thermal comfort in the building, which will be the focus of the investigation, particularly in connection to the building's energy efficiency considering student task performances. EnergyPlus, which is a software for building energy modeling, is applied to evaluate the energy consumption of buildings under a variety of circumstances related to their design. With the use of a variety of simulations, the goal of this study is to provide building design options that are both the most efficient and the most cost-effective for the case study building.

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Narouei, F., Tang, Z., Wang, S., Hashmi, R., Welch, D., Sethuraman, S.*, et al.*

Effects of Germicidal Far-UVC on Ozone and Particulate Matter in a Conference Room.

ChemRxiv Home, (2025)

The application of 222 nm light from KrCl excimer lamps (GUV222 or Far-UVC) is a promising approach to reduce the indoor transmission of airborne pathogens, including the SARS-CoV-2 virus. GUV222 inactivates airborne pathogens and is believed to be relatively safe for human skin and eye exposure. However, UV light initiates photochemical reactions which may negatively impact indoor air quality. We conducted a series of experiments to assess the formation of ozone (O3), and resulting formation of secondary organic aerosols (SOA), induced by commercial far-UVC devices in an office environment (small conference room) with an air exchange rate of 1.3 h-1. We studied scenarios with a single far-UVC lamp, corresponding to the manufacturer's recommendations for disinfection of a space that size, and with four far-UVC lamps, to test conditions of greater far-UVC fluence. The single lamp did not significantly impact O3 or fine particulate matter levels in the room. Consistent with previous studies in the literature, the higher far-UVC fluences lead to increases in O3 of 5 to 10 ppb above background, and minor increases in particulate matter (16% ± 10 % increase in particle number count). The use of far-UVC at minimum intensities required for disinfection, and in conjunction with adequate ventilation rates (e.g. ANSI/ASHRAE recommendations), may allow the reduction of airborne pathogen levels while minimizing the formation of air pollutants in furnished indoor environments.

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Hao, R., Lin, X., Yao, Z., Wang, M., Sun, J., Wang, H.

Emission characteristics, environmental impact, and occupational health risks assessment of volatile organic compounds (VOCs) in the hairdressing sector.

Atmospheric Pollution Research, Vol. **16** n°(5), (2025)

The common presence of volatile organic compounds (VOCs) in hair products means that VOCs are emitted from these products during hairdressing procedures, which can be harmful to both the indoor atmospheric environment and human health. This study focused on sampling VOCs during various hairdressing activities and discussing the correlation between the types of hairdressing activities and the

emissions of VOCs. The study revealed that hair treatment had the highest contribution to the VOCs concentrations, at 1294.11 µg/m3. Oxygenated volatile organic compounds (OVOCs) were the most significant VOCs components in all hairdressing activities, especially contributing over 80% of the VOCs in hair treatment, ordinary perm, hair setting of an ordinary perm, and hair coloring. OVOCs and alkenes were the primary components that significantly influenced the formation of ozone due to their substantial contribution of concentration and their chemical reactivity, respectively. The secondary organic aerosol formation potential (SOAFP) for hair treatment, cold wave, hair setting of a cold wave, ordinary perm, hair setting of an ordinary perm, and hair coloring were 0.76, 0.93, 0.85, 0.86, 0.93, and 1.36 µg/m3, respectively. Acrolein and acetaldehyde were the main non-carcinogenic species, with acrolein posing a non-carcinogenic risk ranging from 4.04 to 22.98, far exceeding the safety threshold. The most significant carcinogenic risks were associated with 1,3-butadiene and acetaldehyde. Therefore, it is imperative to impose stringent regulations on the management of hair salons and the operations of hairdressers.

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Bittar, M., Araujo, A. L. D., Almeida, O. D., Martins, T., Sousa, M.

Enhancing indoor airflow: insights on cross ventilation through CFD simulations.

Ambiente Construído, Vol. **25**, (2025)

In recent years, the architectural design process has undergone significant advancements due to computational design, enabling real-time exploration of alternatives through parametric modeling. In the design of buildings, a comprehensive understanding of measurement systems, particularly in the context of natural ventilation, can guide decision-making processes through tests using computational simulations. This paper aims to determine the flow patterns of natural ventilation in indoor environments under five specific conditions using Computational Fluid Dynamics Analysis (CFD) Ansys Fluent® R22. Five configurations are analyzed and compared to a control sample. Adhering to scientific rigor and employing computational techniques, it was possible to achieve satisfactory inferences for indoor airflow. Our findings indicate that the diagonal positioning of openings substantially accelerates wind speed in indoor environments. This design strategy supersedes the need for more openings when the goal is to enhance air speed and indoor air renewal.

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Park, S., Yan, H., Song, D.

Estimation of time-varying air exchange rate using occupant-generated CO2.

Journal of Building Engineering, Vol. **103**, (2025)

This study introduces a novel method for estimating the time-varying air exchange rate (AER) in indoor environments by utilizing CO_2 generated by occupants. Accurately estimating the AER is critical for understanding the building energy performance, as it significantly affects the heating, cooling, and ventilation loads. Traditional AER models often assume a static value that fails to account for real-time variations influenced by factors such as occupant behavior, environmental conditions, and ventilation strategies. The proposed sliding window approach segments time-series data, identifies changes in ventilation modes, and optimizes AER estimation. This method was validated through field measurements conducted over a 12-week period in a university classroom, demonstrating its accuracy and practical applicability. The predicted AER was validated through indirect and direct comparisons, thereby confirming the reliability of the estimation process. This method also enables the estimation of occupant numbers based on CO_2 emissions, further enhancing its utility in real-world applications. This method holds the potential for application in building energy simulations, particularly in scenarios involving demand-controlled ventilation and indoor air quality management systems that require real-time AER adjustments. Additionally, this method can be integrated into smart building management systems to optimize energy consumption and enhance occupant comfort based on real-time conditions.

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Cheng, J., Ma, X., Wang, Y., Hu, L., Zheng, Z., Zhang, H.

Experimental and simulation study on fresh air dehumidifier with separated heat pipe.

Applied Thermal Engineering, Vol. **268**, (2025)

Dehumidification is crucial for maintaining indoor air quality in fresh air handling units. Recent research is focused on improving dehumidification capacity, which still suffers from high energy consumption. This study proposes a fresh air handling unit with a separated heat pipe to enhance both dehumidification and coefficient of performance. The thermal resistance of separated heat pipes was analyzed theoretically, and their start-up characteristics and isothermal performance were experimentally tested under various temperature conditions. A system simulation model was developed to evaluate the performance of the system under different working conditions. The climate adaptability of the fresh air handling unit with a separated heat pipe was assessed. The results show that the system achieves a 16.89 % improvement in dehumidification and a 19.35 % increase in coefficient of performance compared to fresh air handling units. The separated heat pipe outperforms gravity heat pipes, with a 13.93 % improvement in dehumidification and an 11.97 % improvement in coefficient of performance. The results of the study highlight the dehumidification capability and energy performance of the system under multivariate and variable operating conditions, offering a more efficient and sustainable solution for indoor air quality management.

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Suresh, R., Fazil, M. M., Kathiravan, R., Nivash, L. M.

Fabrication and testing of CanSat with drone.

AIP Conference Proceedings, Vol. **3162** n°(1), (2025)

The tilt The hexacopter drone a sophisticated aerial vehicle, is manually operatedto carry out its critical task of dropping CanSat using a specially designed dropping mechanism. This mechanism, meticulously engineered by own. Facilitates the analysis of toxic and non-toxic gases present in drainage and mining areas. Through its innovative design and advanced functionality, the hexacopter drone contributes to improved environmental monitoring and safety in these regions. Beyond gas analysis, the hexacopter drone’s dropping mechanism can be utilized for other purposes as well. For instance, it can be adapted to drop additional payloads, such as environmental monitoring devices or remote sensing equipment, expanding its capabilities in assessing various parameters simultaneously. This versatility enhances the overall effectiveness and value of the hexacopter drone as a comprehensive environment monitoring tool.

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Sahoo, M., Kumar, A., Thakur, V.

Factors Inhibiting Implementation of Green Healthcare Initiatives in India’s Healthcare Sector.

International Management Perspective Conference(IMPeC-2025), IIM Sambalpur, India, 30th January to 1st February 2025

This study aims to analyze and prioritize the factors inhibiting the implementation of GHI in the healthcare sectors of India. Design/Methodology/Approach: A mixed-methods approach is employed in the research, where a qualitative approach explores the in-depth knowledge and perceptions of healthcare workers and stakeholders, and a quantitative approach is used to measure the extent to which the awareness about green healthcare practices and factors like adoption rates, resource availability, and healthcare outcomes. The study employed thematic analysis for the qualitative data and fuzzy-AHP methodology for the quantitative data analysis. Findings: The research discovered various factors, viz., high initial costs, regulatory and policy gaps, complex supply chains, etc., are responsible for resistance to change or adoption of GHI among healthcare professionals. In light of the present circumstances, characterized by the dangers of viruses and climate change to individuals and the environment, the healthcare sector must allocate greater resources towards environmental protection initiatives. The sustainability of our environment is essential for our survival on Earth. Originality: The study is the first initiative to identify factors inhibiting the implementation of GHI and indicates that GHI adoption among healthcare personnel is a must for sustainability. Limitations/Implications: The study is limited to the operational and environmental

perspective of the GHI approach to sustainability; future research may be conducted based on social and other perspectives. Practical Implications: The research indicates that GHI is a unique way to achieve sustainability. This research holds considerable importance for healthcare stakeholders by offering a thorough understanding of the green healthcare concept and the function of GHI within the healthcare environment. Moreover, this will provide readers and scholars with a foundation for additional research on GHI. Social Implications: The stakeholders of healthcare sectors, such as patients, regulatory bodies, and policymakers, have a unique idea of sustainability through this GHI, which is helpful to healthcare professionals and stakeholders to a great extent.

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Kumar, S., Sakagami, K., Lee, H. P.

From Sustainability to Regeneration: Improving Indoor Environment Quality Through Innovative Design.

Preprints.org, (2025)

The pursuit of sustainable design has made strides in improving building practices, yet traditional approaches often fall short in addressing the holistic needs of both the environment and human well-being. This research delves into the emerging field of regenerative design, which extends beyond sustainability by seeking to restore and enhance ecological and human systems. By integrating regenerative principles into indoor environments, this study evaluates their impact on indoor environmental quality (IEQ). Through a comprehensive literature review, the research demonstrates that regenerative design can significantly enhance air quality, thermal comfort, lighting, and acoustics, ultimately creating healthier and more productive indoor spaces. This paper also discusses potential challenges and outlines future research directions to further advance the application of regenerative design in building practices.

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Ullhaque, A. D.

Health risk assessment of indoor air quality and its association with sick building syndrome symptoms among workers.

Public Health Risk Assesment Journal, Vol. **2** n°(2), (2025), 71-85 p.

The study used a cross-sectional study design, and the data was processed with the chi-square test and multiple logistic regression tests with a sample of all production area workers at PT X. A total of 91 workers included in this study. Carbon monoxide, temperature, humidity, PM10 and formaldehyde were measured using a particle counter and wind speed was measured using an anemometer. Measurements were taken at 17 different points. Findings: The results showed that 85 out of 91 workers (93.4%) experienced symptoms of sick building syndrome. There is a relationship between temperature (p-value=0.013) and wind speed (p-value=0.031) symptoms of sick building syndrome. The most dominant variable is the formaldehyde (POR=0.457). Conclusion: It is concluded that the variables associated with symptoms of sick building syndrome are temperature and wind speed, with formaldehyde being the most dominant. The company is advised to monitor indoor air quality regularly and improve the ventilation system at the production area.

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Šeduikytė, L., Kolarik, J.

Healthy, Digital and Sustainable Buildings and Cities.

MDPI-Multidisciplinary Digital Publishing Institute; 2025.

The following Special Issue on Healthy, Digital, and Sustainable Buildings and Cities features 16 papers that collectively explore enhancing built and urban environments through a focus on health, technology, and sustainability. Topics include biophilic design, strategies to reduce indoor air pollution, and the Smart

Readiness Indicator's application in educational buildings. The included studies also address thermal comfort in sports halls, trends in sustainability research, and project management methodologies for construction projects.

Energy efficiency is a key focus, with studies on indirect evaporative cooling, indoor air quality in schools, and building renovation packages in Latvia and Lithuania. The use of low-cost VOC sensors for ventilation and the benefits of eco-friendly building materials are examined. Additionally, the energy consumption of the wine industry is analyzed, providing design guidance for warehouses.

Methodologies for developing indoor air quality dashboards and classroom indices in educational facilities are proposed, and the integration of modern technologies in civil engineering education is reviewed. The featured authors also discuss the restoration of historic buildings and the adaptation of refugee camps for sustainability and livability. This collection offers valuable insights and promotes multidisciplinary collaboration in building and urban design of the future.

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Zhang, J., Kwok, H. H. L., Cheng, J. C. P.

Heritage Building Air Diffusion Performance Index: HVAC Diffuser Layout Evaluation for Heritage Building Preservation.

International Conference on Computing in Civil and Building Engineering (ICCCBE)

25-28 August 2024, ÉTS, Montréal, Québec, Canada

As poor Indoor Air Quality (IAQ) causes adverse effects on building conditions of heritage buildings, ventilation systems need to maintain satisfactory IAQ for heritage building preservation. In indoor spaces, commercial historic buildings that have been regenerated are generally fitted with heating, ventilation, and air conditioning (HVAC) systems. HVAC was optimized by previous studies to improve IAQ for human comfort. However, there is a lack of research that investigates the influence of HVAC diffuser layouts on IAQ features and quantitatively evaluates the performance for preserving heritage building indoor components by suitable index. This research proposed a methodology for HVAC diffuser layout enhancement by quantifying its performance to maintain satisfactory IAQ for heritage building preservation using Heritage Building Information Modelling (HBIM). Heritage Building Air Diffusion Performance Index (HBADPI) was developed to evaluate the HVAC diffuser layout performance by calculating the satisfactory IAQ percentage for the preservation of heritage building indoor components. The proposed methodology was illustrated by the practical case FWD HOUSE 1881. Computational Fluid Dynamics (CFD) scenario studies of diffuser arrangement cases were quantitatively evaluated using HBADPI. The optimal layout improved multiple IAQ satisfaction by 14.68%, which helps preserve heritage building indoor components.

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Tugores, J., Macarulla, M., Gangolells, M.

Hybrid grey box modelling of indoor air quality and thermal dynamics in indoor environments.

Energy and Buildings, Vol. **334**, (2025)

Heating, ventilation, and air conditioning (HVAC) systems play a critical role in maintaining indoor temperature and air quality, directly impacting occupant health, well-being, and productivity. However, their high energy consumption necessitates optimization, for which model predictive control (MPC) has proven highly effective. Grey box modelling has emerged as a valuable tool for assessing indoor air quality and thermal comfort, particularly in real-world scenarios. Traditionally, these models have addressed temperature and air quality separately, which often results in incomplete parameterization and inaccuracies. The primary objective of this paper is to develop a hybrid grey box model that integrates air and thermal dynamics to improve accuracy in both domains. The methodology involved developing four grey box models to estimate ventilation airflows using indoor CO2 concentration data and six thermal models to estimate thermal properties and heat gains using indoor temperature data. To ensure accurate

parameterization, measurements of outdoor conditions, occupancy, and HVAC operations were incorporated. The results revealed that models treating infiltration and mechanical ventilation as mutually exclusive (IAQ-3 and IAQ-4) and those integrating ventilation heat gains from estimated airflows (T-6) performed most effectively. This hybrid approach underscores the benefits of incorporating ventilation heat loos or gains, based on airflow estimation derived from indoor air quality (IAQ) models, into thermal modelling, significantly improving accuracy and reducing parameter variability. The findings demonstrate the potential of this methodology for applications in ventilation management and HVAC optimization. By enhancing energy efficiency and improving indoor air quality, this approach supports the development of healthier, more sustainable indoor environments.

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Adamović, D.

Impact of indoor air quality on workers health and productivity.

Forging the Future: Pioneering Approaches in Business, Management and Economics Engineering to Overcome Emerging Global Challenges - 2024 Harmful health outcomes from exposure to air pollution have been documented for decades. Air pollution outdoors and indoor air pollution have detrimental effects on workers' health and productivity in different working environments. Indoor air pollution seriously affects occupants' health as individuals spend most of their time indoors completing other activities of daily living, working, and sleeping. A large number of epidemiological research have demonstrated that the influence of indoor air pollution results in damaging health effects. Various kinds of indoor air contamination have different impacts on occupants. Environmental conditions and individual human characteristics are associated with illness distribution, and people experience results differently. Some factors may enlarge the risk of adverse health outcomes, while others can promote health and wellbeing. This paper aims to summarize the different aspects of exposure to indoor air pollution and the adverse effects of indoor air pollution on workers' health and productivity in various working environments

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Modaqeq, T., Joia, R., Tulepov, M., Nurgaliuly, O. A., Baimahankyzy, K. Z.

An In-Depth Analysis of Car Air Filters: Structure, Function and Operational Mechanisms.

European Journal of Theoretical and Applied Sciences, Vol. **3** n°(1), (2025), 249-260 p.

Modern lifestyles necessitate adaptation to contemporary technologies, as approximately 80% of our time is spent indoors or in vehicles. This raises significant concerns about indoor air quality, including issues like particles, dust, volatile organic compounds (VOCs), harmful gases, unpleasant odors, and biological contaminants such as airborne viruses and bacteria. Car air filters play a crucial role in trapping dirt particles that can negatively impact engine performance and longevity. They also purify the air inside the cabin, significantly enhancing passenger health. In developed countries, around 80% of cars utilize nanotechnology-based filters that effectively eliminate odors and trap fine particles. This study aims to examine the impact of air pressure on engine performance using both clean and dirty air filters. Research indicates that dirty air filters lead to increased fuel consumption and greenhouse gas emissions while diminishing engine performance. Specifically, fuel consumption rises and exhaust gas temperatures increase with dirty filters. In modern cars equipped with electronic pressure transducers, notable pressure differences between clean and dirty filters are observed. For carburetor engines, dirty filters markedly reduce acceleration performance. Consequently, maintaining clean air filters is vital for optimal engine performance, fuel efficiency, and reduced emissions, while nanotechnology filters enhance filtration and improve overall vehicle performance.

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Nahian, M. R., Siegel, J. A.

An in-situ test method for portable air cleaners.

Building and Environment, Vol. **272**, (2025)

Portable air cleaners (PACs) are widely used to reduce indoor airborne particle concentration. However, the performance of an air cleaner fluctuates over time within the same environment and varies across different environments due to factors such as room volume, ventilation, sources of particles, room mixing, background loss rates, and outdoor particle levels. This study presents an in-situ test methodology for PACs to capture the actual performance using low-cost sensors. The testing consisted of switching from air cleaner operation to placebo operation every 2.5 h for two weeks and the effectiveness was calculated from the PM2.5 concentrations during neighboring placebo/air cleaning conditions. The median PM2.5 effectiveness of three types of tested PACs varied from 36.3 % to 94.3 % in residential, 0 % to 66.7 % in classroom, and 11.4 % to 33.3 % in office environments owing to the variation of room size, clean air delivery rate (CADR), sources, and background loss rates. Although the CADR of the top performing PAC is approximately 8.8 times higher than the least performing PAC, the median effectiveness only improved by a factor of 2.4. One type of low-cost sensor predicted a similar median effectiveness when compared to a more robust instrument, while another type of low-cost sensor resulted in a lower effectiveness, likely owing to its reduced responsiveness during periods with elevated PM2.5 concentrations. Overall, this study contributes to the development of an in-situ testing methodology for PACs, which will facilitate the adoption, use, and evaluation of PACs.

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Cinquin, P.

Indoor air quality at a French university: a participatory CO2 measurement campaign highlights the wide gap between reality and the law

medRxiv, (2025)

Poor indoor air quality has been demonstrated to increase the risk of transmitting infectious agents and to expose individuals to the phenomenon of sick building syndrome. In light of these findings, most countries have established specific guidelines regarding indoor air quality in university rooms. In France, for instance, the maximum permissible concentration of carbon dioxide (CO2) in university rooms without mechanical ventilation is set at 1,300 parts per million (ppm), and the minimum volume per occupant is 15 m3. For rooms with mechanical ventilation, the minimum clean air flow rate is 25 m3/h/occupant.The primary objective of this study was to design and demonstrate the feasibility of a simple, cost-effective method for comparing the reality of indoor air quality in all university rooms with legal requirements. The secondary objectives of the present study were to demonstrate the efficacy of the proposed method in identifying and reporting problematic situations, and in issuing practical recommendations.Mobile CO2 sensors (Aranet4) were provided to volunteer lecturers to measure the CO2 concentration during and after classes. The number of occupants and the condition of openings were also recorded. These data were supplemented by measurements from 117 fixed Carbon Nexelec sensors. The data were then fitted to a model, which enabled the characterization of air quality and the estimation of the gauge reduction required to comply with the law.None of the 14 rooms without mechanical ventilation complied with the legal minimum of 15 m3/occupant. 75% of the third quartiles of CO2 concentrations during classes exceeded 2692 ppm. In rooms with mechanical ventilation, median clean air flow was 15 m3/h/occupant at 100% occupancy (9 m3/h/occupant for the first quartile). In 32 out of 41 rooms with mechanical ventilation (78%), the clean air flow was estimated to be below the legal minimum of 25 m3/h/occupant at 100% occupancy. Concentrations in excess of 5,000 ppm were observed in 23 of the 101 rooms equipped with fixed sensors.The proposed method has demonstrated its feasibility in real-life conditions. For the purpose of evaluating the air quality of all rooms affiliated with universities, it is recommended that this method be used in a systematic manner. The findings of this study indicate that a significant proportion of the examined rooms may not be in accordance with the relevant legislation, thereby jeopardizing the health of the occupants. In order to comply with the law, the method proposed here to estimate gauge reduction should be applied.

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Schroeffer, K. G., Pagel, É. C.

Indoor air quality in healthcare buildings and ventilation systems.

PARC: Pesquisa em Arquitetura e Construção, Vol. **16**, (2025), e025007-e025007 p.

This study aims to list the main IAQ factors in healthcare centers discussed in the literature, related to the building and occupational health. The methodology of this research relied on the Systematic Literature Review using three journal databases, which resulted in the analysis of 19 articles. The result observed that even with the existence of standards for IAQ, several healthcare buildings did not have adequate air renewal systems, contributing to an increase in the concentration of contaminants in the spaces. Moreover, the lack of outdoor air filtration was one of the main factors for the increase in the indoor concentration of Particulate Matter (PM), coming from outside. Central air-conditioning system proved to be more efficient than natural ventilation and non-central mechanical systems. This study intends to contribute to the establishment of both design and administrative guidelines in search of a healthy work environment.

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Sudniks, R., Ziemelis, A., Nikitenko, A., Soares, V. N. G. J., Supe, A.

Indoor Microclimate Monitoring and Forecasting: Public Sector Building Use Case.

Information, Vol. **16** n°(2), (2025)

This research aims to demonstrate a machine learning (ML) algorithm-based indoor air quality (IAQ) monitoring and forecasting system for a public sector building use case. Such a system has the potential to automate existing heating/ventilation systems, therefore reducing energy consumption. One of Riga Technical University's campus buildings, equipped with around 128 IAQ sensors, is used as a test bed to create a digital shadow including a comparison of five ML-based data prediction tools. We compare the IAQ data prediction loss using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) error metrics based on real sensor data. Gated Recurrent Unit (GRU) and Kolmogorov–Arnold Networks (KAN) prove to be the most accurate models regarding the prediction error. Also, GRU proved to be the most efficient model regarding the required computation time.

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Park, S., Kagi, N., Umishio, W., Shinohara, N., Kim, H.

Influence of mechanical ventilation systems on indoor VOC concentrations in residential buildings.

Journal of Asian Architecture and Building Engineering, (2025), 1-21 p.

Air change rates are often insufficient due to high airtightness and insulation for energy conservation. VOCs from building materials, furniture, and occupant activities can accumulate, impacting health. Since mechanical ventilation systems influence indoor air quality, understanding their relationship with VOC levels is crucial. This study conducted field measurements on houses with balanced ventilation (N = 16) and unbalanced ventilation (N = 17) systems during winter and summer. The measurements showed that no houses exceeded the VOC guideline values. During summer, the average air- change rate in the living room of houses with unbalanced ventilation was lower than 0.5 h−1. In both winter and summer, the bedroom's average air change rate was also lower than 0.5 h−1. The concentrations of α-pinene and d-limonene, which are derived from both buildings and household goods, tended to be higher in houses with lower ventilation rates. Overall, homes with balanced ventilation had lower VOC concentrations and were found to be better for managing indoor air quality than homes with unbalanced ventilation.

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Iskandar, N. P., Yoganingsih, T., Husadha, C.

The Influence of Work Environment on Employee Performance at CIMB Niaga Bank.

Jurnal Akademik Ekonomi Dan Manajemen, Vol. **2** n°(1), (2025), 330-339 p.

The purpose of this study is to determine the Influence of the Work Environment on Employee Performance at Bank CIMB Niaga where the existence of a supportive work environment will improve employee

performance. This study uses a quantitative method with sampling, namely Purposive Sampling. The number of samples used in this study was 33 respondents from PT CIMB Niaga employees. The testing of the research hypothesis was carried out with the help of the SPSS version 25 program. The results of the research that have been carried out are variables that affect each other, namely the work environment has a positive and significant influence on the performance of PT CIMB Niaga employees.

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Sabeur, A., Mostefa Tounsi, I., Morsli, S., El Ganaoui, M.

Insights on the Air Quality Story, Standard's Evolution, and IoT's Role to Monitor IAQ for an Appropriate Indoor Environment.

In: Urban Pollution - Environmental Challenges in Healthy Modern Cities. IntechOpen; 2025.

As our cities continue to grow and develop, the issue of urban pollution has become a growing concern. This problem is causing several environmental challenges that require urgent attention. The rise in greenhouse gas emissions and other toxic pollutants generated by urban areas is damaging the quality of our air and water resources. This poses a severe threat to human health and the infrastructure of our cities. The book "Urban Pollution - Navigating New Frontiers in Healthy Modern Cities" will analyse the challenges posed by urban pollution and provide potential solutions for a sustainable future. The book will cover a wide range of topics on urban pollution, including the complexities of the issue. It will offer insights to policymakers, researchers, and citizens with ideas that can be used to collaborate and create a future where access to clean air and water is a fundamental human right. By implementing these solutions, we can work toward interventions to improve the built environment and promote healthy modern cities. It is our collective responsibility to address this issue and ensure a sustainable future for ourselves and future generations.

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Mohammadi, M., Assaf, G., Assaad, R. H.

Integrating immersive virtual reality (VR) technologies and multimodal IoT-enabled wireless sensor networks for real-time smart human-centered HVAC building system interaction and thermal comfort assessment and visualization.

Smart and Sustainable Built Environment, (2025)

This research has the potential to revolutionize the way built environments are managed and interacted with, where facility managers can monitor, assess and visualize thermal comfort in real-time as well as interact with the HVAC systems and control multimodal IoT devices in the real-world from a distance through virtual facility models. The proposed framework's ability to provide dynamic and continuously updated assessments of thermal conditions in real-time positions it as a valuable tool for prompt adjustments to optimize occupants' comfort levels. Ultimately, the proposed framework provides an intuitive and immersive platform to manage thermal comfort, thus promoting healthier, more productive and eco-friendly indoor environments.

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Kocak, O., Bunyatova, U.

Integrating smart air purifiers in building controls: A conceptual approach to infection and energy management.

Energy Reports, Vol. **13**, (2025), 2545-2554 p.

The COVID-19 pandemic has highlighted the critical need to maintain high indoor air quality. While in-duct systems are effective, their high installation costs make portable systems a more accessible and cost-effective alternative for improving indoor environments. However, energy consumption remains a key challenge with existing solutions. This study introduces the Adaptive Air Purification and Ventilation System

(APVS), an intelligent technology designed to improve air quality, control airborne infections, and optimize energy use in residential and public spaces. The APVS integrates adaptive fan control with IT applications, motion sensors, and dust and virus particle sensors. Using real-time data, it dynamically adjusts ventilation based on occupancy, providing energy-efficient and effective antiviral protection. A case study was conducted in a public administration building with 14 employees and a total indoor volume of 1170 m³ to be cleaned. The performance of the APVS was also compared to three commercially available units. Key results demonstrated the superiority of the APVS in key metrics: an air turnover rate of 4.49 units/h versus 2.61 units/h, energy efficiency per unit volume of 0.001388 kW/m³ versus 0.001412 kW/m³ , and effective air cleaning capacity of 1750 m³/h versus 1510 m³/h. In addition, its adaptive sensing technology reduced power consumption to 1.7 kW, demonstrating significant energy savings. These results establish the APVS as a sustainable, innovative solution for improving indoor air quality, reducing airborne infections, and saving energy, making it highly suitable for various applications.

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Nateghi, S., Kaczmarczyk, J., Zabłocka-Godlewska, E., Przystaś, W.

Investigating the impact of physical barriers on air change effectiveness and aerosol transmission under mixing air distribution.

Building and Environment, Vol. **272**, (2025)

This research investigated the effectiveness of desk partitions in reducing airborne infection risks in classroom environments. Experiments were conducted in a controlled test chamber with two designs of mixing air distribution systems (MV1 and MV2). Nebulized aerosols and bioaerosols were utilized in the presence of physical barriers to simulate the transmission of exhaled droplets from a source of infection and to assess this transmission among individuals sitting near this source. In addition, local air change effectiveness (ACE) was evaluated based on age of air measurements using CO2 tracer gas decay method. Results showed that air change effectiveness without partitions were higher than with partitions for both systems, indicating that partitions create an obstacle for effective ventilation air distribution. Moreover, MV1 exhibited significant ACE reductions at some points with partitions, while MV2 maintained high ACE values across all points. For aerosol measurements, MV2 achieved high concentration reduction rates (CR) around 0.8 across all points, whereas MV1 exhibited mixed results, with some points showing negative CR values due to airflow obstruction. For bioaerosol generation bacteria Micrococcus luteus was used. Sampling of bioaerosol measured Micrococcus luteus concentrations, 4- and 45-minutes post-generation. MV2 system was more effective in reducing bacterial concentrations with partitions, while MV1 showed variable results, with partitions reducing concentrations at some points but increasing them at others. Overall, MV2 demonstrated superior performance in maintaining lower contaminant concentrations, especially for environments requiring prevention measures or where maintaining well-mixed air is difficult.

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Pilzak, H.

Jakość powietrza wewnętrznego i wentylacja w dyrektywach UE.

Rynek Instalacyjny, Vol. n°(10), (2024), 80-82 p.

The article presents the key changes introduced by the latest revision of the EPBD Directive (2024/1275) and the EED Directive (2023/1791) concerning Indoor Environmental Quality (IEQ), with a focus on Indoor Air Quality (IAQ). Indoor Air Quality plays a crucial role in the health and comfort of building occupants, as emphasized by new European Union regulations on energy efficiency. The 2024 EPBD directive obliges member states to implement standards for indoor environmental quality, including ventilation, temperature, and humidity. Building modernization, while improving energy efficiency, may negatively affect air quality if appropriate ventilation systems are not considered. Experts highlight the need to integrate ventilation with Building Management Systems (BMS). Modernization challenges include a lack of regulations and the high costs of implementing modern systems.

https://www.rynekinstalacyjny.pl/artykul/instalacje-wentylacyjne-klimatyzacyjne/170824,jakosc-powietrza-wewnetrznego-i-wentylacja-w-dyrektywach-ue

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Guo, R.

Large-scale three-dimensional real-time particle tracking velocimetry for indoor flow studies.

Université Côte d'Azur. Thèse 2024

Cet article décrit l'application de techniques de vision par ordinateur à la mesure de vitesse pour deux écoulements générés en Cellule de Hele-Shaw (CH). Un Écoulement Laminaire de Poiseuille (ELP) est généré par la vidange de la CH remplie d'un liquide préalablement au repos. La figure 1 donne un aperçu de la configuration expérimentale. Nous proposons un nouvel algorithme combinant le Recalage d'Image Direct (RID) et une reconstruction volumique en vision monoculaire permettant de suivre le mouvement d'un motif marquant le liquide au niveau moléculaire. La méthode nous permet d'obtenir une mesure expérimentale de l'ELP dans des géométries à accès optique limité.

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Gül, F., Eroğlu, H.

Low-Cost IoT Mesh Network for Real-Time Indoor Air Quality Monitoring.

2024 9th International Conference on Communication and Electronics Systems (ICCES)

This paper presents a low-cost and scalable Internet of Things (IoT)-based solution for real-time IAQ monitoring using the ESP32-S3 microcontroller, MQ-135 gas sensor, and DHT11 temperature and humidity sensor. The system utilizes Bluetooth Low Energy (BLE) for communication, enabling wireless transmission of data to mobile devices from IoT nodes. The network uses the ESP-NOW protocol to create a robust mesh network that enables efficient data transmission across large indoor spaces. The design prioritizes low power consumption, ease of deployment, and cost-effectiveness, making it suitable for smart home and small-scale commercial applications. The proposed solution aims to address the limitations of traditional IAQ monitoring systems, which are often expensive, difficult to scale, and lack real-time, easily accessible data. The system measures key IAQ parameters, including CO2, temperature, and humidity, providing real-time data accessible through a mobile app. The calibration of the designed IoT nodes accomplished through industry standard "Extech SD800: CO2, Humidity and Temperature Datalogger", Experimental results demonstrate the system's accuracy, reliability, and low power consumption, making it a promising solution for continuous IAQ monitoring.

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Shi, T., Wang, K., Yang, W., Wang, P., Ao, Y., Zhang, Y.*, et al.*

Mechanism model combined with deep learning models for accurate prediction of indoor air pollution in residential and commercial spaces.

Journal of Building Engineering, Vol. **103**, (2025)

The risks associated with particulate matter on human body are not limited to outdoor environments only. Research showed that outdoor particulate matter can infiltrate inside spaces through various processes, such as window and door diffusion, as well as wall penetration. Majority of the neural network based existing methods for predicting indoor air quality are opaque models lacking clear physical interpretability. These models overlook the optimization of input samples as well as the seasonal spatial and temporal distribution of the concentration of particulate matter. As a result, the accuracy of predictions is compromised, and the computational load of the models is also increased. This paper presents a novel model for predicting the concentration of indoor particulate matter, called the Warped K-means - Osmotic Diffusion Mechanism - LASSO Attention Temporal Convolutional Network (WKM-ODM-LATCN). Firstly, redundant variables are eliminated using the LASSO regression algorithm. Then, sub-datasets are created

with distinct seasonal characteristics using the warped K-means algorithm. Models of osmotic diffusion mechanism are constructed for each season based on the principle of particulate mass balance. Finally, based on the optimized dataset and predicted spatio-temporal information about the mechanism model as the input values of the multidimensional attention temporal convolutional network, the concentrations of indoor particulate matter in the future time periods are finally predicted. The obtained results demonstrate that WKM-ODM-LATCN has superior prediction accuracy in comparison to earlier approaches, hence confirming the practicality and dependability of the proposed approach. This study aims to effectively include spatial and temporal environmental data in order to accurately estimate the concentration of indoor particulate matter. Additionally, it demonstrates strong physical interpretability.

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Zamboti, M., Tenório, K., Toscano, F., Cunha, C., Cesar, A.

Retrofitting Methodology for Hospital Buildings

Revista Técnica "energía", Vol. **21** n°(2), (2025), 69-80 p.

The building and construction sectors account for over one-third of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions. At the same time, hospital buildings are often among the least energy-efficient. Enhancing the energy performance of existing hospital buildings through retrofitting measures presents a significant opportunity for cost and energy savings. However, hospitals have unique challenges, such as continuous occupancy, heavy medical equipment, and strict safety regulations. Additionally, the lack of financial incentives and supportive policies are among the biggest barriers to retrofitting hospital facilities. This paper proposes an energy management methodology for selecting the best retrofitting measures for hospital buildings. Moreover, the study seeks to define a priority ranking for the energy efficiency measures selected in an energy retrofit project, distinguishing between primary and supplementary actions. The methodology includes a generic process flow diagram, a systematic flowchart to facilitate decision-making, and two tables outlining primary and supplementary retrofitting measures.

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Patil, A. G., Pramanick, B., Madhukar, A.

MOS Based Gas Sensors for Monitoring of Air Pollution: A Review.

IEEE Sensors Journal, (2025)

This review thoroughly assesses gas sensors and crucial role in addressing the environmental pollution, explicitly focusing on air pollution. This review offers a comprehensive analysis of the semiconductor metal oxide sensors and their mechanisms and relevant factors affecting sensing. It discusses the historical context and fundamental concepts of gas sensors, emphasizing MOS gas sensor technology and its advantages over alternative sensor types. Additionally, it explores the performance parameters of MOS based gas sensors and various methods to enhance their sensitivity and selectivity. The priority lies in crafting the article to benefit both newcomers seeking to delve into Gas sensor research and established researchers, aiming to enhance the sensing capabilities of MOS, gas sensors.

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Roy, S., Pan, S., Sivaram, S., De, P.

Naphthalimide-based fluorescent polymeric probe: a dual-phase sensor for formaldehyde detection.

Science and Technology of Advanced Materials, Vol. **26** n°(1), (2025)

Formaldehyde (FA) is a common pollutant found indoors and outdoors, posing a significant threat to human health. Therefore, developing sensitive and efficient detection methods for FA is essential for environmental monitoring and protecting public health. Herein, we report a naphthalimide-conjugated water-soluble polymeric fluorescent probe for the detection of FA in both aqueous and vapor phases using fluorimetric

methods. The aromatic amines present in the side chain of the polymer react with FA, forming a Schiff base (imine bond). This imine formation inhibits the photoinduced electron transfer (PET) process within the polymer, leading to a ?turn-on? fluorescence under 365?nm UV light. The probe is capable of selectively sensing FA with a detection limit as low as 1.36?nM in aqueous medium. The formation of imine is confirmed for the model reaction between 6-(4-aminophenyl)-2-(4-((4-vinylbenzyl)oxy)phenyl)-1?h-benzo[de]isoquinoline-1,3(2?h)-dione and FA by electrospray ionization mass spectrometry (ESI-MS) and nuclear magnetic resonance (NMR) titration methods. The mechanism behind ?turn-on? FA sensing is investigated using density functional theory (DFT) analysis. Additionally, the study demonstrates a facile approach for covalently attaching the polymer on the surface of a filter paper surface via ultraviolet (UV) light-induced cross-linking. Such polymer attached paper exhibits FA vapor sensing through changes in fluorescence intensity. A naphthalimide-conjugated fluorescent water-soluble polymeric probe is reported for formaldehyde sensing in an aqueous (nanomolar level) phase within a very short time (1?min) with high selectivity. Also, this work demonstrates a facile approach for FA vapor sensing through changes in fluorescence intensity.

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Duan, X., Zhu, Y., Cao, J.

Novel classification criterion of indoor organic pollutants based on their relative abundances in house dust and indoor air.

Building and Environment, Vol. **270**, (2025)

Indoor organic pollutants are typically categorized into (very-)volatile, semi-volatile, and low-volatile organic compounds (VOCs, SVOCs, and LVOCs) for easier handling. Existing criteria have been found to be neither consistent nor precise in classifying many compounds, primarily because they have not captured the apparent differences between VOCs, SVOCs, and LVOCs: VOCs predominantly exist in the air, LVOCs mainly reside in reservoirs like house dust, and SVOCs serve as transitional compounds between them. Based on a systematic analysis of the relative abundance of compounds between house dust and indoor air (the two crucial transfer and storage media of indoor organic pollutants), a novel criterion was proposed in this study, i.e., VOCs: log Koa < 6, SVOCs: 6 ≤ log Koa ≤ 9.8, and LVOCs: log Koa > 9.8 (Koa is the octanol-air partition coefficient of compounds). In doing so, we developed a novel equation to estimate the dust-air partitioning quotient of compounds (Kd), incorporating for the first time the effects of Koa and indoor conditions on Kd; and subsequently we determined the boundaries between VOCs, SVOCs, LVOCs based on the Kd equation and Monte Carlo simulations (to assess the combined effects of various indoor conditions). Consistence between classification results and literature evidences, as well as good agreement between estimates of the Kd equation and measured data retrieved from the literature, justified the proposed criterion. The novel criterion should facilitate the selections of most suitable methods for the chemical analysis, exposure assessment, and effective controls of organic pollutants in indoor environments.

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Sotek, J., Makos, K. A., Hawks, C.

Occupational Exposure Risk Assessment of Library Collections Work Tasks and Storage Areas.

Studies in Conservation, (2025), 1-10 p.

Cultural heritage sites, including libraries where historical texts are available, are responsible to staff, research visitors, and the public for providing a safe and healthy work and educational experience. Identifying hazards inherent and acquired on collections, or in contaminated work areas and storage environments, has become more prevalent with the use of XRF analysis (for metals), knowledge of collector's notes, and records of conservation methods. However, this is only source identification data, that typically does not directly correlate to the potential health risk from specific work tasks and where routes of exposure exist. An occupational exposure assessment, conducted by a qualified health and safety professional, will determine actual risks during work tasks via personal sampling devices and media,

surface and dermal wipes, and other methods. An exposure assessment case study is presented, related to the testing and assessment of worker exposure to and workspace contamination from selected metals (arsenic, chromium, lead, and mercury) within historical collections at a regional library. Personal sampling results quantified potential inhalation exposures, wipe samples verified the presence of contaminants on hands (potential ingestion risk), and surface wipe results identified cross-contamination in collection storage and work areas. Detailed recommendations for improved safe work practices, personal protection, and other controls were offered. Understanding hazard sources, routes of exposure, and surface transference defines both the potential health risk and the methods to best control that exposure. Safety and collection preservation and conservation are not disjointed topics. Safety can work hand in hand to support the protection of collections.

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An, I.-H., Kwak, D.-B., Lee, J., Park, S.-H., Yook, S.-J.

Optimal Operating Positions of Two Air Purifiers for Improving Indoor Air Quality in Hospital Wards.

Journal of Hospital Infection, (2025)

Summary Background Maintaining high indoor air quality (IAQ) in hospital wards is crucial, particularly in settings lacking proper ventilation. This study investigates the effectiveness of air purifiers in enhancing IAQ under varying conditions, including ventilation systems and curtains. Aim This study aims to evaluate the optimal operating positions of two air purifiers to enhance IAQ in hospital wards under varying ventilation and curtain use conditions. Methods This study employed a combination of experiments and computational fluid dynamics (CFD) simulations across twenty scenarios, analysing the impact of air purifier placement on the age of air, a key IAQ metric. Findings This study found that the positioning of air purifiers greatly influenced IAQ, with reductions in the age of air ranging from 19% to 44% depending on the configuration. The most effective placement involved active ventilation systems and unfolded curtains, leading to a significant decrease in the volume-averaged age of air. Conclusion This study concludes that optimal placement of air purifiers in hospital wards can significantly improve IAQ, with reductions in the age of air by up to 44%. Specifically, when ventilation systems were active and curtains were unfolded, the age of air was reduced to as low as 318 seconds, representing a 27% to 44% improvement over less-effective configurations. These findings emphasise the critical role of strategic air purifier placement in reducing airborne infection risks and enhancing patient safety in healthcare environments.

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Optimal Strategies in Industrial Environmental Managemant: Contribution to Air Quality Control at PT United Tractors.

Ecotrends, Vol. **1** n°(1), (2025), 1-12 p.

Air pollution is a major challenge for big cities, including Jakarta, which has experienced a significant decline in air quality. This research explores the optimal strategies implemented by PT United Tractors to control air quality in their industrial area. Primary data was collected through direct surveys and interviews with company employees, while secondary data came from the company's sustainability report and previous research studies. The results of the analysis show that industrial growth around PT United Tractors increases air pollutant emissions, causing potentially serious health impacts for employees. PT United Tractors has taken steps to reduce the impact of air pollution. This strategy demonstrates a strong commitment to environmental sustainability. By strengthening preventive approaches, raising employee awareness, and investing in green technology, PT United Tractors can continue to improve its performance in maintaining a clean and sustainable environment.

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Cho, W. Y., Kim, S.-H., Na, H.-C., Lee, W., Kang, H. W.

Optimal ventilation strategies by artificial intelligence for gaseous materials reduction in livestock building.

Computers and Electronics in Agriculture, Vol. **231**, (2025)

The ventilation system inside a livestock building is a critical method for improving livestock productivity and health management. Mechanical ventilation systems generate a consistent airflow to expel airborne pollutants such as methane, ammonia, carbon dioxide, and particulate matter produced by livestock. However, these systems may pose challenges due to energy consumption and economic burdens on livestock farms. In this study, we introduce a strategy for analyzing and controlling the optimal operation modes of the mechanical ventilation system in a livestock building using artificial intelligence. We trained artificial intelligence to predict the optimal operating mode of the mechanical ventilation system, which has five operating modes based on the location of livestock within the building, represented by the concentration of gas pollutants, particularly carbon dioxide. Numerical simulations were conducted to analyze the reduction in carbon dioxide levels for each operating mode based on the location of livestock. The livestock positions were digitized into 2D binary images, and these images were labeled with the optimal operating mode for input data to train a convolutional neural network model. The trained convolutional neural network model can predict the optimal operating mode for the location of livestock using 2D binary images representing their positions. To apply the trained convolutional neural network model in real-time to the livestock building, we developed an algorithm to convert the real-time position of livestock into 2D binary images. The images allowed us to predict the optimal operating mode of the mechanical ventilation system for the real-time position of livestock in the actual livestock building. The convolutional neural network model presented in this study can be valuable for determining and predicting the optimal operating mode of the ventilation system for reducing airborne pollutants inside a livestock building.

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Anyi, C.

Optimising HVAC Operations in Hospitals with AI and IoT: An Economic Analysis.

Proceedings of the International Workshop on Navigating the Digital Business Frontier for Sustainable Financial Innovation (ICDEBA 2024)

As critical public service facilities, hospital buildings face unique challenges in managing energy consumption due to their dense occupancy and extensive equipment usage. HVAC systems account for a substantial portion of hospital energy expenditure. This study addresses these challenges by leveraging AI and IoT technologies to optimise HVAC operations. AI-based control systems continuously learn from data and adapt to complex operational environments, maintaining optimal indoor conditions while minimising energy consumption. IoT sensors enable real-time monitoring and automated control, reducing cooling capacity waste and increasing energy efficiency. The economic benefits of this approach are analysed, including reduced energy consumption, HVAC operating costs, and total economic benefits over ten years. The study finds that AI-driven HVAC systems significantly outperform traditional energy management methods, offering long-term financial advantages and improved occupant satisfaction. The findings highlight the potential of AI and IoT technologies to revolutionise HVAC energy management in hospitals, providing significant economic and operational benefits.

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Sonowal, J., Roy, A., Anandalakshmi, R., Muthukumar, P.

Optimization of hybrid organic-inorganic desiccant composition and parametric analysis for air conditioning applications.

Journal of Building Engineering, Vol. **103**, (2025)

Liquid desiccant technology is a promising green-energy alternative to conventional methods for regulating building thermal comfort, and the choice of desiccant material plays a pivotal role in its effectiveness. The design, cost, and environmental impact of a liquid desiccant system are largely influenced by the type of liquid desiccant used. This study proposes an innovative, low-corrosive and cost-effective desiccant by optimally blending potassium formate (HCOOK) with magnesium chloride (MgCl2) for desiccant-based air

conditioning applications. Various weight ratios (S1, S2, S3, and S4) and concentrations (30 wt% to 60 wt%) were empirically tested to optimize the mixture. HCOOK serves as the primary corrosion inhibitor, while MgCl2 influences cost, working concentration, and density. Based on kinetic analysis and favorable thermo-physical properties, the desiccant mixture S3 (55 % HCOOK and 45 % MgCl2) at a 40 wt% concentration was selected. The addition of HCOOK reduced the corrosion rate of S3 (0.0153 mm/year) by 53.6 % compared to pure MgCl2 (0.033 mm/year). Experimental tests of S3 in a real-time liquid desiccant system revealed a moisture removal rate (MRR) and dehumidifier efficiency (ηdeh) ranging from 2.2 g/s to 8.4 g/s and 28 %–82 %, respectively. The evaporation rate (ER), desiccant mass fraction index (DMFI), and regenerator efficiency (ηreg) varied between 1.6 g/s and 8.2 g/s, 20.3 %–61 %, and 9 %–69 %, respectively. These findings demonstrate the potential of this novel organic-inorganic desiccant blend for large-scale industrial applications, offering reduced costs, lower corrosion, and a minimized environmental footprint.

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Ryńska, J.

Parametry fizykochemiczne i mikrobiologiczne jakości powietrza wewnętrznego.

Rynek Instalacyjny, Vol. n°(11), (2024)

Physicochemical and microbiological indoor air pollution results both from outdoor and indoor sources and correlates with both outdoor air quality and indoor emission. Indoor air quality, understood not only as proper temperature and humidity but also purity in terms of physicochemical and microbiological properties, will be required legally as a part of zero-emission building performance, as new European legislation stipulates. The paper presents the possible ways to parametrize the indoor air quality requirements proposed by both the industry and science communities and design guidelines including indoor air quality indicators and parameters of ventilation installation.

https://www.rynekinstalacyjny.pl/artykul/instalacje-wentylacyjne-klimatyzacyjne/171901,parametry-fizykochemiczne-i-mikrobiologiczne-jakosci-powietrza-wewnetrznego

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Vergelli, L., Frasca, F., Bertolin, C., Favero, G., Siani, A. M.

Review of organic gaseous pollutant concentrations in indoor conservation spaces.

Environmental Pollution, Vol. **368**, (2025)

Gaseous organic and inorganic pollutants negatively affect cultural heritage materials, accelerating their deterioration. Although assessing their concentrations is crucial, these pollutants are rarely measured in indoor spaces housing artefacts, known as conservation spaces. This review examines 39 selected studies (1990–2023) encompassing 58 case studies in which gaseous organic pollutants were monitored in such spaces. Acetic and formic acids emerged as primary contributors to the deterioration of collections. The sites monitored, predominantly in Europe, were categorised into three scales: building scale (37 museums, 12 archives, 4 palaces, 7 worship places), room scale (exhibition rooms in 45 sites, storage rooms in 16 sites) and enclosure scale (conservation or display cases, microclimate frames, cabinets in 18 sites). Passive samplers were used more frequently than active ones, with continuous monitoring equipment being limited to total volatile organic compounds (VOCs). Across the sites, the median concentration and 95th percentile values for various pollutants were as follows: acetic acid at 68 ppb and 624 ppb; acetaldehyde at 8 ppb and 77 ppb; formic acid at 30 ppb and 227 ppb; formaldehyde at 27 ppb and 265 ppb; and total VOCs at 66 ppb and 1655 ppb. No clear correlation was found between pollutant concentrations and the use of old versus new enclosures, as both types can contribute to indoor pollution. Further research is needed to develop continuous monitoring technologies, improve active and passive sampling methods and establish standardised concentration thresholds to better preserve cultural heritage.

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Dikshit, M., Tiwari, R. C.

A review on occupational health hazards & future challenges in the printing industry.

World Journal of Pharmaceutical Research, Vol. **14** n°(3), (2024), 214-222 p.

Work-related occupational hazards are more frequent in industrialized developing countries & these hazards may affect different systems of the body. 1.9 million occupational hazard cases are reported worldwide, out of which 17% are contributed by India. With respect to the printing industry, India stands at the 8th place in the printing industry. This review article describes the background of the printing industry, occupational health hazards & its health impact on different systems of the body. This article also throws light on future challenges, like risk management strategies, preventive measures and technology advancements according the safety standards.

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Maji, B., Nanda, O. P., Badhulika, S.

Self-healable and self-adhesive hydrogel based gas sensor using carbon quantum dots embedded ZnMn2O4 platelets for ppb level sensing of toluene at room temperature.

Chemical Engineering Journal, Vol. **507**, (2025)

Self-healing and self-adhesive materials are some of the most promising smart materials that are being actively explored for sensing applications. In this work, we report a multiresponsive, self-adhesive, and self-healing hydrogel based on carbon quantum dots (CQDs) embedded in zinc manganite ($ZnMn_2O_4$) for the detection of toluene at room temperature. CQDs are synthesized from stone apple shell via hydrothermal method and $ZnMn_2O_4$ is synthesized using a co-precipitation process. An optimized ratio of composite crosslinked by polyvinyl alcohol, boric acid, and acrylic acid-based hydrogel (CQDs/$ZnMn_2O_4$ HG) is prepared using cyclic freezing-thawing method. Detailed morphological analysis reveals the even distribution of CQDs on the $ZnMn_2O_4$ platelets which are then encapsulated in the polymer matrix. The hydrogel shows green luminescence under 365 nm wavelength of UV light and photoluminescence (PL) properties in aqueous medium. The performance of $ZnMn_2O_4$, CQDs/$ZnMn_2O_4$, composite, and CQDs/$ZnMn_2O_4$ HG towards toluene sensing is investigated where CQDs/$ZnMn_2O_4$ HG shows the best response. The CQDs/$ZnMn_2O_4$ HG-based toluene sensor exhibits a wide dynamic range of 550 ppb to 50 ppm with fast response/recovery speed (26 s/36 s), and a low detection limit of ~ 502 ppb. This hydrogel sensor also displays an excellent selectivity towards toluene when compared to other volatile organic compounds (VOCs). A comprehensive sensing mechanism is also discussed using band energy diagram. The improved toluene detection performance is attributed to the structural merits and synergetic effects including the formation of p-p heterojunction, high specific surface, and abundance of O2 functional groups (Oc% = 72.24 %). Further, this hydrogel shows outstanding mechanical properties in addition to self-adhesion and self-healing efficiency (within 5 min) thus establishing itself as a robust material for wearable applications.

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Taamte, J. M., Tchuente Siaka, Y. F., Nducol, N., Yakum-Ntaw Younui, S., Ahmadou, G., Etende Essama, R. C., *et al.*

Smart electronic device for air quality and exposure risk assessment.

Smart Science, (2025), 1-15 p.

This article reports on the measurement of air pollutants and assessment of health exposure risks in two reference hospitals in the city of Yaoundé, using a locally manufactured smart electronic device for the measurement of highly toxic air pollutants. This low-cost device is based on an Atmega328 microcontroller, toxic gas sensors (O_3, PM2.5, CO, CO_2 and NO_2), temperature (T), relative humidity (RH) sensors, and XBee modules to establish the Internet of Things (IoT). In each of the two hospitals, 2 weeks of measurements conducted from October 15 to 30, 2023 at Biyem-assi Hospital and from September 1 to 15, 2023 at Central Hospital. The average values obtained were 0.96 ± 0.06 ppm and 0.37 ± 0.09 ppm for O_3, 39.66 ± 10 µg/m3 and 39.72 ± 10 µg/m3 for PM2.5, 0.41 ± 0.01 ppm and 0.42 ± 0.02 ppm for CO,

316.55 ± 63 ppm and 305.84 ± 89 ppm for CO2, and 0.43 ± 0.01 ppm and 0.45 ± 0,02 ppm for NO2 in Biyem-assi and Central Hospitals, respectively. These values were used to assess the risk of exposure through the Air Quality Index (AQI) and the Air Quality Health Index (AQHI2.5).

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Egger, L., Sosada-Ludwikowska, F., Steinhauer, S., Singh, V., Grammatikopoulos, P., Köck, A.

SnO2-Based CMOS-Integrated Gas Sensor Optimized by Mono-, Bi-, and Trimetallic Nanoparticles.

Chemosensors, Vol. **13** n°(2), (2025)

Chemical sensors, relying on electrical conductance changes in a gas-sensitive material due to the surrounding gas, have the (dis-)advantage of reacting with multiple target gases and humidity. In this work, we report CMOS-integrated SnO2 thin film-based gas sensors, which are functionalized with mono-, bi-, and trimetallic nanoparticles (NPs) to optimize the sensor performance. The spray pyrolysis technology was used to deposit the metal oxide sensing layer on top of a CMOS-fabricated micro-hotplate (µhp), and magnetron sputtering inert-gas condensation was employed to functionalize the sensing layer with metallic NPs, Ag-, Pd-, and Ru-NPs, and all combinations thereof were used as catalysts to improve the sensor response to carbon monoxide and to suppress the cross-sensitivity toward humidity. The focus of this work is the detection of toxic carbon monoxide and a specific hydrocarbon mixture (HCmix) in a concentration range of 5–50 ppm at different temperatures and humidity levels. The use of CMOS chips ensures low-power, integrated sensors, ready to apply in cell phones, watches, etc., for air quality-monitoring purposes.

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Zhang, C., Li, G., Hu, Z., Jiang, W., Yan, K., Li, Y.*, et al.*

Study on solar combined refrigerant radiant air conditioning system.

Journal of Building Engineering, Vol. **103**, (2025)

Energy consumption associated with building operations accounts for a substantial share of global energy use. This study proposes a solar combined refrigerant radiant air conditioning system in this context. A guest room in a hotel in Beijing is used as the simulation case. The TRNSYS software is used to develop simulation models for both the solar combined refrigerant radiant air conditioning system and the conventional heat pump air conditioning system. An operational strategy is then formulated for the entire cooling season, and its performance is simulated. Analysis of the simulation results led to the following conclusions: the hotel room temperature was maintained at approximately 26 °C, with relative humidity ranging from 40 % to 60 %. The results indicated that the model of the solar combined refrigerant radiant air conditioning system provided a more stable cooling performance; the COP of the solar combined refrigerant radiant air conditioning system is about 4.50, while that of the traditional heat pump air conditioning system is 2.33, the performance of the solar-assisted refrigerant-based radiant air conditioning system outperforms that of the conventional heat pump air conditioning system; the solar combined refrigerant radiant air conditioning system saves about 109.9 kWh compared to the conventional heat pump air conditioning system, which is about 23.3 % energy saving. This study integrates solar technology, heat pump technology, phase change energy storage, and rotor dehumidification to offer an innovative solution for summer cooling, characterized by improved comfort, reduced energy consumption, and enhanced environmental sustainability.

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Frasca, F., Vergelli, L., Etheridge, S. P., Layton, J., Siani, A. M.

A survey on the procedures adopted in cinematographic archives for monitoring and mitigating Vinegar Syndrome.

IAQ 2024 The International Conference on Indoor Air Quality in Heritage and Historic Environments

A key issue in cinematographic archives is preserving cellulose tri- and diacetate motion picture films (hereafter called, films) affected by "Vinegar Syndrome" (VS). This term commonly refers to the vinegar smell occurring when cellulose tri- and diacetate films are deteriorating. The chemical process involves the deacetylation of the film support caused by the reaction of water with a bound acetyl group, resulting in hydroxyl substitution and production of acetic acid. This reaction can be initially triggered by specific microclimate conditions. Once triggered, the process is autocatalytic, meaning it cannot be stopped or reversed. Consequently, the acetic acid released by a VS-affected film can more rapidly induce deacetylation in other films. Consultative surveys can be a mainstay for leading to a comprehensive understanding of current practices and exploring new strategies. The ensemble of information gathered from surveys is pivotal to highlight current challenges and identify potential improvements. For this reason, a survey was designed to target film archivists and conservators who work with cellulose acetate films. The online survey was conducted from December 5th, 2023, until January 15th, 2024, targeting members of the Association of Moving Image Archivists (AMIA) and the email list of the International Federation of Film Archives (FIAF). It included 16 quantitative and qualitative questions (both open and close) to gather statistics and detailed information on: a) the amount of collection affected by VS; b) devices and procedures used for monitoring the level of VS; c) strategies for mitigation and recovery of films in good conservation state as well as for disposal of films with severe VS. A total of 96 individuals responded to the survey, mostly belonging to public and private organisations, worldwide distributed. Less than 30% of respondents' collections were estimated being VS-affected by most respondents. The most used devices for monitoring the level of VS were dye-coated paper strips, that change colour according to the amount of acetic acid released by the film. However, there is no unique strategy to test collections for VS, nor a fixed frequency for testing as it can be performed once a year, every 6-10 years or never. There was greater agreement among respondents on the use of ventilated cans and/or cold storage to mitigate VS affecting films. However, only 54% of respondents affirmed to isolate films in special vaults; the others complained about a lack of space and/or budget. In the case of films with severe VS, there is no unique policy for the recovery, as it is evaluated case by case according to the availability of other copies, curatorial interest, and item's uniqueness. By gathering and analysing data from experts and insiders in the field, it is possible to highlight areas in need of improvement and promote collaborative efforts to preserve these invaluable cultural treasures for future generations.

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Mileikovskyi, V., Tkachenko, T., Kotelkov, L.

Theoretical simulation of natural air exchange and indoor air quality with an example of a green wall introduction.

Results in Engineering, Vol. **25**, (2025)

Nowadays, most modern buildings have mechanical ventilation with heat recovery. But old buildings are equipped with natural ones. Some modern houses are equipped with automatic window control to save energy. Therefore, natural ventilation is topical. To clean and sanitize the air, "green structures" are effectively used. The roles of indoor and outdoor ones in sustainable development are specified. The plants absorb and produce carbon dioxide dependent on time, which causes the corresponding requirements for ventilation. The provision of adequate indoor air quality by natural ventilation can be tested by simulation. It can be performed effectively and accurately without computational fluid dynamics using the methods for aeration of enterprises after adaptation of assumptions to other-type buildings. In this study, we improve the method for calculations of aeration by A. Tkachuk using the integral flow concept. It allows uniformity of calculations of a single flow and backflow in holes. The simulation results of a single-room flat with a green wall confirm that natural ventilation sometimes can't keep enough indoor air quality. Therefore, mechanical ventilation or a combination of both ventilation types is necessary.

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Sadick, A.-M., Chinazzo, G.

What did the occupant say? Fine-tuning and evaluating a large language model for efficient analysis of multi-domain indoor environmental quality feedback.

Building and Environment, Vol. **274**, (2025)

Qualitative feedback from occupants on indoor environmental quality (IEQ) in unstructured text can provide valuable insights into the causes of comfort and discomfort in buildings. This feedback can be collected from open-ended survey questions, interviews, crowdsourced data, or innovative home automation technology that can transform voice inputs into text. However, manual text data processing is time-consuming and requires significant efforts to extract relevant insights, such as text classification into IEQ categories (i.e., visual, thermal, air quality and acoustic). Most IEQ studies that automated text feedback classification into IEQ categories relied on keyword matching, which cannot understand the context of some keywords, potentially leading to incorrect classification. To address this issue, we automated the detection and categorisation of unstructured IEQ feedback by adopting the Bidirectional Encoder Representations from Transformers (BERT) language model architecture and fine-tuning it on 14,622 manually labelled IEQ text feedback. The resulting model, IEQ-BERT, achieved a prediction accuracy of 93 % and macro average precision, recall, and F1-scores of 0.93, 0.94, and 0.93, respectively, across the five considered classes (i.e., acoustic, indoor air quality, thermal, visual, or No IEQ). Therefore, the model can effectively distinguish text concerning IEQ and identify which IEQ domain – acoustic, indoor air quality, thermal, visual, or their combinations – is being reported. IEQ-BERT can be used alone or integrated into building automation systems to identify patterns and trends of occupant feedback, prioritise areas for improvement, and support the development of targeted strategies to improve IEQ. This research contributes to developing efficient methods for analysing occupant feedback, ultimately leading to improved building performance and occupant quality of life.

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Bauer, A.

Working from home as an adaptation strategy to heat: Comparing temperatures and workers' assessments for 203 offices and 107 homes.

Building and Environment, Vol. **272**, (2025)

This contribution considers whether working from home (WFH) can be an effective adaptation to increasing summer heat for office workers. The mixed-method study presents temperature data from 203 offices and 107 home workspaces in Southern Germany, along with survey data from >100 workers at both locations during a hot period in June 2023. Home workplaces had both lower mean temperatures and less occurrence of elevated temperatures or overheating (operationalised as degree hours above 26 °C and 30 °C) than passive offices. A comparison with mechanically cooled offices is offered, but should be interpreted cautiously due to the small N and energy saving measures being in place at the time. Measured temperatures had significant effects on workers' perceived heat stress and productivity in a mixed-effects regression model. Individual variables age, gender, general activity level and general thermal preference were also explored. Barriers for WFH were explored through stakeholder interviews. We conclude that flexible WFH can be a means to protect workers' health depending on the specific office and work situation, and could offer workers better adaptive options and potentially a slight psychological benefit.

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